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CONTENTS.

An Asterisk (*) denotes an illustrated article.

OFFICIAL NOTICES—
- Notice Respecting the "Wrinkle Department," Western Gas Association 365
- March Meeting, Society of Gas Lighting 365
- March Meeting, Guild of Gas Managers 365
- Twelfth Annual Meeting of the Ohio Gas Light Association 365

EDITORIALS—
- Briefly Told 366
  - The Allen and Addicks Papers—Osterberg's Synopsis of Current Electrical Literature—Notes.
- Twenty-sixth Annual Meeting of the New England Association of Gas Engineers—Official Report—Revised by the Secretary—Continued from page 333 366
  - First Day, Afternoon Session—The Development of Candle Power, by Mr. W. S. Allen—Discussion—Acetylene Gas, by Mr. W. R. Addicks—Discussion.
- Statistical Studies Concerning Labor Conditions 374
- Notes on Carbon Bricks in Blast Furnaces 375
- Mr. J. M. Somerville on Gas Burners 375
- The Radiating Power of Welsbach Mantle Material 376

ITEMS OF INTEREST FROM VARIOUS LOCALITIES 376
- Annual Meeting, Belleville, Ont.—Death of Mr. N. W. Turner—Annual Meeting, Grand Forks, N. Dak.—The Norristown (Pa.) Company May Change Hands—To Extend the Main System, Vicksburg, Miss.—Annual Reports, Lighting Department, Danville, Va.—Contract for the Berlin Iron Bridge Co.—The Benicia (Cal.) Gas Works Shut Down—The Key City Company, of Dubuque, Ia., to Go Ahead—Mr. Todd's Record, so far, at Hyde Park, Mass.—Gas and Electricity Divorced, at Pawtucket, R. I.—Change in Ownership, Windsor, Ont.—Betterments at Elmira, N. Y.; Bordentown, N. J.; Princeton, N. J.—Something from the 11th Annual Report, Mass. Board of Commissioners.

The Market for Gas Securities 378

[OFFICIAL NOTICE.]

Notice Respecting the "Wrinkle Department," Western Gas Association.

OFFICE OF THE SECRETARY, NEW ALBANY, IND., Feb. 10, 1896.

Contributions to the "Wrinkle Department," of which Mr. Geo. T. Thompson, of St. Louis, is editor, should be sent to him not later than March 20. The "Wrinkle Department" is a distinctive and valuable feature of the meetings of the Western Gas Association. Its success has been due wholly to the personal solicitations of its editor, who has been persistent in his efforts to collect a valuable contribution. This year it is hoped that contributors will voluntarily and promptly send Mr. Thompson their "Wrinkles" for the Chattanooga meeting.

JAMES W. DUNBAR, Sec'y.

[OFFICIAL NOTICE.]

March Meeting, Society of Gas Lighting.

OFFICE OF THE SECRETARY, Feb. 28, 1896.

The March meeting of the Society of Gas Lighting will be held in the Arena, No. 39 West 31st street, New York City, at 3 P.M. of Thursday, March 12.

FRED. S. BENSON, Sec'y.

[OFFICIAL NOTICE.]

March Meeting, Guild of Gas Managers.

OFFICE OF THE SECRETARY, Feb. 28, 1896.

The March meeting of the Guild of Gas Managers will be held in Young's Hotel, Boston, at noon, Saturday, March 14.

A. K. QUINN, Sec'y.

[OFFICIAL NOTICE.]

Twelfth Annual Meeting of the Ohio Gas Light Association.

OFFICE OF THE SECRETARY, COLUMBUS, O., March 2, 1896.

The following is a list of papers to be read at our twelfth annual meeting, which will be held in Cincinnati, O., Wednesday and Thursday, March 18 and 19, 1896:

"Utilizing Gas Liquor in Small Gas Plants," by Mr. B. P. Holmes, Youngstown, O.

"Dots and Dashes," by Mr. E. H. Jenkins, Covington, Ky.

"Mains and Services; their Extension into New Territory," by Mr. Geo. Light, Dayton, O.

"Selling Gas," by Mr. Henry L. Doherty, Columbus, O.

"Ventilation of Gas Heated Rooms," by Mr. Donald McDonald, Louisville, Ky.

It is expected that unusual interest will be given to the Thursday morning session, to which no one but members of the Association will be admitted, and at which time especial attention will be given to the "Question Box," to which all are requested to contribute.

The Grand Hotel, where the sessions will be held, is located at the corner of Fourth street and Central avenue, and is conveniently reached from all railroad depots. The Columbia avenue cars run di-

rect to the hotel from the Pennsylvania and C. H. and D. depots, and passengers arriving at the Grand Central station have only to cross the street to take an elevator which will land them on the office floor of the hotel. The hotel is run on both the American and European plan, and the rates will be as follows: American plan, $3 per day and upwards; European plan, $1.50 per day and upwards.

Accommodations can be obtained at other hotels, as follows: Gibson House, $3 to $5 per day; Burnett House, $3 per day; Palace Hotel, $2 and $2.50 per day; Dennison Hotel, $1.50 and $2 per day.

Those contemplating attending the meeting are advised to secure their rooms in advance.

Membership application blanks can be obtained from the Secretary.

A. P. LATHROP, Sec'y.

BRIEFLY TOLD.

THE ALLEN AND ADDICKS PAPERS.—The several chapters in our issue for this week of the official report of the New England meeting include two interesting papers. The first of these is by Mr. W. S. Allen, of Boston, who wrote most entertainingly on "The Development of Candle Power," and although his compilation naturally dealt principally with enrichers, and their method of use, that had been pretty well tried practically, he nevertheless ventured a passing paragraph respecting acetylene as an aid to the enriching of gas of inherently low candle power. However, he is very diplomatic in his reference to the subject, and a fair inference from his speculations respecting the relative values of benzol and acetylene as enrichers, is that benzol is likely to prove the better card of the two for the gas engineer. And it is quite certain that in this interpretation he is in accord with the majority; since we know fairly well what can be done with benzol, both in point of enriching value and the cost thereof. The last paragraph of his paper is, however, a notable leaning towards heresy; for we hold to the belief that it "would" *not* "be better to use small burners and more of them," nor would it be better to "furnish gas of lower candle power and distribute the light properly," because it is quite an easy matter to distribute light properly that emanates from large burners, the lighting agent being a high candle gas. In fact, the suggestion to use smaller burners and more of them has the faintest ring of a special plea for acetylene gas—pure and unmixed. Of course, the matter of distributing the light properly is a matter that belongs to any and every means of lighting. The paper by Mr. Walter R. Addicks, of Boston, on "Acetylene" is complete in matter, fair in treatment and honest in tone; but the power figures are seemingly all too much on the side of cheap carbide production. We espouse Mr. Nettleton's position in this regard, whose part in the discussion on the paper was firmly spoken; and that engineer has had some pretty conclusive experience in the item of the cost of water power. Mr. Taber, also, had something to say on the power question, and his speech fits in very nicely with the Nettleton views thereon. A third speaker in the debate, who spoke right to the point, was Capt. W. H. White, and even if he was a trifle oratorical, he undoubtedly put the carbide-acetylene conundrum just where it belongs. If acetylene gas can be produced at a certain figure (and no one yet knows what that figure is) the gas makers of the country are the ones who want it and will have it, since it will be worth more to them than to anyone else.

OSTERBERG'S SYNOPSIS OF CURRENT ELECTRICAL LITERATURE.—We are in receipt of a copy of an excellent "Synopsis of Electrical Literature," by Max Osterberg, E.E., A.M., of this city, which indexes, in complete and easily understandable form, everything of worth that was printed in 1895 concerning electrical literature. The publishers are the D. Van Nostrand Company, of this city, and we have no hesitation in saying that to those interested in the subject of electricity the book is worth many times the price that is charged for it—$1.

NOTES.—Through the negligence of the printers in replacing in the form cuts that had been removed for "underlaying," Figs. 1 and 2, in the description in our last issue of the "Bristol Recording Thermometer for Atmospheric Ranges of Temperature," were inverted.——A Pintsch plant is to be erected at Phillipsburg, N. J., to furnish gas for the lighting of the passenger coaches of the Lehigh Valley Railroad.——The Newark (N. J.) Gas Company has contracted with the United Gas Improvement Company, of Philadelphia, for two sets of its standard Lowe water gas apparatus, double superheater form, to be erected at once at the station formerly known as the works of the Citizens Company. The new plant will have a daily generating capacity of 1½ million cubic feet or over, and will replace the gasogenes of somewhat uncertain type hitherto used there. Candor, however, compels the admission that, uncertain as the type of the to-be-superseded gasogenes is, they nevertheless did a lot of good work in their time,

[OFFICIAL REPORT—REVISED BY THE SECRETARY—CONTINUED FROM PAGE 333.]

TWENTY-SIXTH ANNUAL MEETING OF THE NEW ENGLAND ASSOCIATION OF GAS ENGINEERS.

HELD AT YOUNG'S HOTEL, BOSTON, MASS., Feb. 20 and 21, 1896.

FIRST DAY—AFTERNOON SESSION.

The President called the meeting to order at 2:30 P.M., and asked Mr. W. S. Allen, of Boston, Mass., to read his paper on

THE DEVELOPMENT OF CANDLE POWER.

Mr. Allen, before proceeding with the paper, explained that its title was somewhat misleading; and suggested that a closer approach to accuracy in its naming would have been reached had it been entitled, "The demand for higher candle power, and some of the less well-known methods for obtaining it." The author then read:

When lighting by gas was introduced, people, accustomed to candles and oil lamps, considered the gas produced at that time, with a candle power of from 10 to 12 candles, a very brilliant light, and this belief continued for many years. Legislation fixed the minimum candle power at 12, and, even as late as 1866, it was argued, before the Massachusetts Legislature, that gas of 12-candle power was much more satisfactory than any higher value because there was too much light given in one place if the gas was of 16 or 20 candles.

In course of time more light was demanded in one place, and the companies were obliged to enrich their product; and this was done with cannel, which still continues to be a very satisfactory means, within certain limits, say, up to 20 candles, but the expense of this method is prohibitive, except in the immediate vicinity of cannel coal fields. There are many advantages in the use of cannel, and perhaps the greatest of these lies in the fact that no changes are necessary in the machinery of gas making, the same retorts and other apparatus serving equally well for cannel and ordinary coals.

The great abundance and cheapness of mineral oils early led to experiments in their utilization for gas making, and it was found that gas of very high candle power could be produced from them; but unless these oil gases were added in moderation, and burners modified to suit, the gas smoked.

When, however, the production of water gas was proven practicable a method was presented for obtaining gas of higher candle power than any we had known, and 25 and 30 candle power became as well known as 18 or 20 had been.

About this same time (1880) the electric arc light made its commercial appearance, and the gas companies began to look for more light. Groups of flat flame burners were used in street lighting, and Siemens and Lungren regenerative burners gave us greater candle powers than we had previously known. Then the incandescent gas burner, which had been known in many forms for nearly 100 years, began to be a commercial burner, and the beautiful light of Dr. Auer von Welsbach was a common sight. With this in the field, and a multiplicity of electric incandescent lights on every hand, there arose a demand for more light from ordinary burners; and I propose to consider some of the methods employed to attain this end—I shall have nothing to say of the ordinary water gas methods; but shall discuss some methods now being used in Europe that are little known in this country.

First, the process of Young and Bell, commonly known as the Peebles process, from the town where it has been most successfully used. The principle of this process, which is very simple, should yield good results. Briefly stated, it consists in decomposing oil at a comparatively low temperature, and passing the mixture of gas and oily vapors through pipes and washers, where it meets the oil, which afterwards flows into the retorts. By this process of oil-scrubbing all the condensable parts of the gas are washed out, and only a fixed gas passes on to the holder, while the condensed vapors pass back to the retorts. This process gives a gas which can be mixed directly with coal gas, and bring its candle power up to a much higher value without smoking than is the case with oil gasified in the usual way.

In England many gas works are now using what they term carburine to enrich the gas after it leaves the holder. This carburine is a very light pretroleum or shale spirit and of a sp. gr. of about .680, and consists mainly of hexane. At 32° F. at least 8 per cent. by volume of carburine can be kept in a state of vapor in the gas. One gallon will raise 8,000 feet of 16-candle power gas one candle, and since this quantity of carburine will be held by 355 feet of gas, at 32°, without condensation, we can, by this means, obtain any candle power suited to the burners which we are to supply.

But a more successful process has now been in use for about three years, in Munich, and has been adopted in several other German cities; namely, carbureting with benzol vapor.

It has long been known that benzol existed in coal gas in small quantities, and that it furnished a large amount of the light—larger than any other part of the illuminants—and it occurred to Dr. Bunte that gas could carry much more of this substance, than naturally occurred there. The vapor tension of benzol vapor is such that, at 32° F., 3.3 volumes can be kept in suspension in gas, while only 1.3 volumes are normally present. This being the case it was comparatively simple to add more benzol, and the apparatus employed in Munich for this purpose consists merely of a revolving drum, dipping into a supply of benzol, over which a current of gas is passed. A broad, thin surface of benzol is thus presented to the action of the gas, and evaporation is rapid. To overcome the cooling effect of the evaporation the apparatus is slightly warmed by a steam coil. In practice only a portion of the gas (the amount being determined by the amount of enrichment desired) is passed through this carbureter, afterwards being mixed with the main body before it enters the holder. As it is possible to regulate very accurately the quantity of gas which is passed through the carbureter, the candle power of the final mixture can be maintained very close to any desired standard.

The Munich experiments show that about 25,000 cubic feet of gas can be raised one candle, by the use of one gallon of benzol; and, also, that gas of 25-candle power can be made as a permanent gas from ordinary coal gas.

The amount of the vapor of benzol retained in suspension by coal gas at 32° is only 3.3 volumes, as against 8 volumes of light, petroleum spirit—carburine—and it would, therefore, seem as if the latter would be a better substance to employ. This, however, is not the case, as the greater amount of light given by benzol vapor renders the use of one-third of the quantity equally valuable.

Or, to express it differently, one gallon of hexane when added to coal gas gives 8,000 candle feet, and one gallon of benzol gives 25,000 candle feet. The practical limits to the use of these two methods of enrichment lie, on the one side, in the amount of these vapors which can be burnt in ordinary burners without smoke, and, on the other side, in their resistance to cold. As regards the first objection, 25-candle power can be obtained with either substance, and gas of this grade burnt without trouble from smoke. So far as resistance to cold is concerned, we all know that both will be condensed, if only the temperature be lowered enough. Even the benzol existing in ordinary coal gas can, by chilling the gas in pipes passing through a mixture of salt and ice, be nearly all condensed. The practical side of this question is very obscure, for we have very few data from which we can determine the temperature of the gas in the holders, away from that in immediate contact with the walls, or in the general distribution system. Leaving out of consideration gas chilled by passing through services or mains exposed to the air, and, therefore, of the same temperature, and, judging from the temperature of the gas taken directly from services, we are, I think, safe in assuming that the general temperature of the gas in the distribution system rarely falls below 40° F. If this is the case little is to be feared from condensation of either of these vapors if employed in quantities within the point of saturation at 32°.

Another possible enricher in which we all take a lively interest is acetylene. This being a gas, will, of course, mix readily with coal gas; being condensable only at very low temperatures it will relieve us of any fear of condensation and, owing to its very high candle power, we can obtain, for mixtures with coal gas, much higher candle powers than we can now reach with ordinary burners—and gas of 30 or 40 candle power may soon be demanded of us. The close chemical connection between benzol and acetylene renders it probable that the fact observed in regard to the high illuminating power of both may be very closely related, and we may have acetylene condensed in the flame into benzol before being burned, or we may have benzol broken up into acetylene before its final decomposition, with separation of carbon. As it has been proven by experiment that acetylene is useless for enriching carbonic oxide, or blue gas, it may be that we shall be obliged to use acetylene only indirectly for this purpose, converting it into first, benzol, by passing it through red-hot tubes in the well known manner. Within a short time a patent was taken out for the use of acetylene to enrich water gas by mixing the two gases, and then passing them through hot tubes, the claim of the patent being that the hydrogen of the water gas and the acetylene combined to give olefiant gas. May it not be equally probable that what takes place is simply the condensation of three molecules of acetylene to benzol.

The same demand for increased light that we have seen in the gradual raising of the candle power of gas burned in ordinary burners, from 12 to 25, or even 30, has also been seen in the development of the incandescent gas light. Starting with a light of only 20 candles, only a few years ago, the mantle of the Welsbach light has been so improved that we now have 80 candles, with less gas consumption; and recently a new burner of this type has been brought forward which gives a light of 200 to 400 candles with a small consumption of gas. This burner, the Denayrouze, is a French invention, and brings into play a well known principle; namely, that the more intimate a mixture of air and gas is made the more rapid is combustion, and since the combustion takes place in a smaller zone, being less dependent upon the outside air, this small zone of combustion concentrates the entire heat of the flame. Using this idea, Denayrouze introduces into the tube of the Bunsen burner of his lamp a fan driven by a very small electric motor, and thus secures an intimate mixture of the gas and air—the flame so produced being thrown into a Welsbach mantle with the result that a far greater light is produced from the same amount of gas. In this way also a flame is produced of sufficient body to allow this burner to be used without a chimney.

To obviate the objection made to the use of an electric motor, Bandsept has arranged a burner in which the motive power for the fan is the pressure of the gas itself. These burners are in practical use in Europe, but I have never heard of any in this country.

A thing to be carefully considered in regard to enrichment is the heating power of the enricher. With the great increase in the use of gas for heat we must seek for some form of enrichment which will give the greatest heat effect. This is now of nearly as much importance for producing light as for heating; for in the incandescent gas light it is the heat of the flame we want, not the light. Benzol and acetylene are both valuable as heat givers, and, perhaps, in these directions our future progress lies. Our aim must be to produce a gas which yields the greatest combined heat and light effect at the least cost.

One question presents itself to us from the consideration of these various methods for increasing the light of our single burners. Have we not gone astray in the direction of trying to concentrate our light in one place? Would it not be better to use smaller burners and more of them, or furnish gas of lower candle power and distribute the light properly. In our rooms we cover the flames with opal and ground shades and thus take away from one-third to one-half of the light effect which we have spent a great deal of money in our works to obtain. Would it not be better to save this expense and teach people how to light rooms? Chandeliers and brackets are not put where they will light the whole room properly, but rather where they will look well with the room—if, indeed, even that care is taken. With the introduction of electric light an attempt was made to arrange lights better, but the field is wide open to any one who will teach the builders and the public how to light rooms of varying sizes, and of differing shapes and colors. And it seems to me quite possible that, for ordinary domestic lighting, we have gone too far in the direction of high candle power. Is it not time to stop and try the effect of less light from each burner and many more burners?

Discussion.

The President—This morning we had an admirable paper on "Photometry" that taught us how to make accurate tests of candle power. We now have this excellent paper, by Mr. Allen, suggesting methods for obtaining good candle power, and how to utilize the various enrichers, some of which we know about and some of which we do not. Now that we have found out how to get good gas, as also how to measure its value in candles, I hope you will act upon the suggestion made by Mr. Allen and ask him all sorts of questions, in order that you may be prepared to work according to some of the methods that he suggests. Mr. Gifford, here is a chance for you to further discuss the question of candle power.

Mr. Gifford—I do not think I know enough of these processes to speak intelligently of them.

Mr. Taber—I would like to ask Mr. Allen if he noticed, in a recent number of the AMERICAN GAS LIGHT JOURNAL, the review of Prof. Vivian B. Lewes' experiment with reference to the temperature of flames. Prof. Lewes refers to the heat of the acetylene flame by referring it to two axes, one vertical and the other longitudinal. Have you any idea with reference to its plausibility? The idea seemed to me to be a probable exposition of some of the flame phenomena, that the heat would inclose, as in a sheath, the unburnt gases, and the temperature vary in both directions.

Mr. Allen—I regret to say that I have not seen the paper of Prof. Lewes, referred to by Mr. Taber; but it seems to me that we know

practically nothing of what goes on inside the flame. We thought we did until within the past year; but suddenly there have come a variety of papers from different men, in which all the old contentions are broken up, as well as all our old theories of what happens within the flame—whether we have a condensation of the hydrocarbons or a breaking up of the hydrocarbons, and afterwards a complete breaking up and separation of the carbon. The only thing we seem to know is that light is given by the actual separation of the solid matter or particles of carbon; but what happens beyond that I have not been able to find out.

The President—Mr. Hinman, you have had a great deal of experience with testing candle power of gases. Here is a paper on that subject. Do you care to ask any questions of Mr. Allen?

Mr. Hinman—Unfortunately I came in late and did not hear the paper.

The President—There is where you were unfortunate. Does any other gentleman care to ask Mr. Allen any questions or to discuss this paper?

Mr. Gifford—I would like to ask Mr. Allen if he knows the cost of benzol and carburine per gallon?

Mr. Allen—The cost of benzol is very much greater in this country than it is in Europe. The price has fallen so rapidly abroad that it has been able to compete with shale spirits. As a rule, in England, carburine is obtained from shale oils, and not from petroleum. What the relative cost would be here I cannot say; but the whole question of tar distillation in this country, and the saving of benzol, is in its earliest stages; and we have not advanced to anything like what they have in Europe; and benzol has not come on the market in any such quantities. Its cost I cannot state.

Mr. Taber—I have an impression that the amount of benzol that is present in our gas, and from which we think we have illuminating power, came with high heats, or about the time that high heats were developed in our retorts. Am I not right in that? Is it not the product of high heats, and is not this a further enrichment in the same direction?

Mr. Allen—I think it will be found that in all coal gas it is a varying quantity. It depends a great deal upon the heat, but it depends a great deal more on the coals used. Different qualities of coal give dif ferent percentages of benzol. Some of the German coals that I have mentioned give double the quantity of benzol in the gas that others give. The main point in all these matters is that we are going too far in the direction of too much light in one place. That is a point upon which I should be very glad to hear someone express an opinion. The distribution of light in rooms is ordinarily very bad. The lights are arranged without any regard to the problem of lighting the room. I think we have really fostered that, by giving excessively high candle power—as is done by the Welsbach and by other high candle power lights. I am referring now only to the means for domestic lighting. In any large, open space it is, of course, an advantage to have a high candle power, and to put it in one place, and to put it high up, so as to light the place well, in the same way that a skylight lights a room. But in ordinary house lighting it strikes me that we have gone a good way in the direction of too much light in one place.

The President—Has not Mr. Clark a word to say on this subject?

Mr. Clark—Unfortunately I was not present at the reading of the paper, and am not prepared to discuss it.

Mr. Taber—I am sorry indeed that the gentlemen should ask for more light on one subject and refuse to give any more light on another subject. I wish, however, to move a hearty vote of thanks to Mr. Allen for his valuable and interesting paper. [Adopted.]

The President—The next paper is that of Mr. Walter R. Addicks, of Boston, Mass on

ACETYLENE GAS.

Those of you who have been reading all that has been written on the subject of calcium carbide and of acetylene gas must have been struck with the wide difference of opinion expressed. This is usually true of any new process that affects great interests. The inventor, particularly of anything even remotely connected with gas, seems to be unconsciously affected by its properties. You read but too frequently of the coming of the fuel or lighting gas of the future, which all may have for 10, 20 or 30 cents per 1,000 feet, as the case may be.

Those of you familiar with the manufacture of gas know that there is a great difference in the value of a foot of the various gases suitable for public uses. It may be that it is this fact, as well as the knowledge of the necessities of the problem, that makes the gas engineer a conservative man. Two things are necessary in a gas—certainty of supply and simplicity in use. A third point is of importance, that is, reasonable safety in the use; but the public demands the best for the money. No other fight was more bitter than that between the water and coal gas interests, and even to this day we hear men stating that water gas is odorless, without knowing that carbureted water gas, of which they are speaking, has an odor which *they* could not distinguish from illuminating coal gas. The gas lighting interests did not take kindly to the electric light; yet it was a blessing in disguise. It is in the interest of the lighting industry to give the greatest amount of light for the least money. The electric and the gas engineer meet on common ground when the manufacture of acetylene gas is considered, and our interest in the subject is mutual. This may not be an occasion when a paper bristling with data is appropriate, but certainly discussion is chiefly valuable.

Acetylene gas has been known for a long time. It is present in small quantities in both carbureted water gas and in coal gas, and in larger quantities in coal gas made from cannel coal. The great interest in it to-day is due to the accidental manufacture of calcium carbide during some experiments conducted by the Willson Aluminum Company, at Spray, N. C., in 1892. It appears that in conducting an experiment with aluminum, powdered carbon and lime were used, with other ingredients. There was found in the crucible a hard, dense, grayish substance. By accident or design a piece was thrown into the head race flowing by the furnace and a violent ebullition attracted attention. This excited curiosity, and a piece was thrown in water and a match applied to the bubbles; a brilliant and smoky flame was the result. An analysis of the gas showed it to be pure acetylene gas.

For two reasons acetylene gas interests the gas engineer; as a possible competitor and as a substitute for oil for enriching purposes. The increase in the cost of oil has checked the natural growth of the manufacture of water gas, and has even increased the use of coal gas where companies have ample capacity for producing water gas. The electric engineer is interested in acetylene gas at least for two reasons; as a possible competitor of the electric light, and as a new use for electrical machinery.

A visit to Spray is of special interest. Major J. Turner Morehead, the President of the Aluminum Company, lives there, and he seems to take great interest in explaining every detail of the manufacture. I made my visit unexpectedly, in accordance with telegraphic instructions, and found Major Morehead absent. Dr. G. DeChalmot, Ph.D., who has charge in his absence, gave me every opportunity for investigation. I was fortunate in meeting Major Morehead, however, as he returned before I left Spray.

The investigator soon changes his preconceived notions of the process of making calcium carbide, if he has pictured on his brain the Willson furnace. You read that the walls of the furnace must be removed to obtain the finished carbide, or that it is tapped out like cast iron from a cupola. The photograph shows the furnace actually used at Spray. The entire carbide plant consists of coke and lime sheds, crushing, grinding and mixing machinery, water wheel, dynamos, transformers, volt and ammeter and furnaces with electric connections. The furnaces are the chief interest. They are built in pairs of ordinary red brick, the upper portion arched; they are about three feet deep, with a brick back, and a central wall from the top of the arch to the base forms the double furnace. Each furnace has at the bottom a cast iron plate about 2 inches thick and about 20 inches square, to which the wire cables are attached leading to one pole of the dynamo. This plate is covered with several inches of carbon. There is then a space of several feet in which the carbide ingot is formed; then, there is a space in which hangs the carbon pencil, and, finally, the arch limits the height of the furnace. The brick front and the upper iron door had been permanently removed from the furnace since the photograph was taken. Only the lower door is adjusted and removed at will. Wire cables are attached to the pencil holder, and the whole pencil is adjustable, as to height, by means of a block and fall leading to a vertical screw with a large stationary hand wheel acting as a nut; the attendant in charge of the dynamo room can manipulate it, having the volt and ammeter before him. The exact position of the pencil is determinable at any moment, and the operator is not exposed to the gases of the furnace. The operation of the plant is somewhat as follows: Coke and lime are brought from the sheds beyond the canal on large cars running on rails. The coke is first crushed and then ground. The unslacked lime is likewise ground. Then the coke and lime are placed in a revolving mixer. This mixer has several hundred pounds of pebbles placed in it, so as to thoroughly mix and still further grind the materials. The grinding apparatus was made by home talent. The coke should be ground so as to pass through a No. 50 mesh. The lime does not have to be ground nearly so fine. Before placing the lime and coke in the mixer they are first weighed to

proper proportions. After mixing, the products are carried to the furnace.

The next operation after those described is to throw on the bottom of the furnace some of the mixture, then the pencil is lowered, and the arc formed between the pencil and mixture spread on the bottom of the furnace by the adjustment of the pencil. Material is shoveled in in increasing quantities as the ingot of carbide is built up. The end of the pencil is kept covered with a foot of the coke and lime mixture which protects the carbon pencil from deterioration, but it must be stoked from time to time. The carbide is built up in a rectangular section, corresponding to the dimensions of the pencil, at the rate of 1 inch in five minutes on the average. After three hours the ingot has grown in height so that the top of the pencil cannot be raised further, being limited by the arch. The current is shut off from this furnace and turned on to a second charge in its neighbor. The carbide ingot as made at Spray must be left to cool for four hours. The iron door is then removed. The mixture which surrounds the ingot of carbide on all sides is scraped out and thrown in a bin to be used again, after being tempered by the addition of coke, and the ingot of carbide is weighed, if you wish it, in its hot state. It is now broken up into pieces for shipment, and you choose the samples at will that you wish tested for gas yield. If the ingot is broken while yet too hot, the carbide will run like molten iron. The carbide is surrounded by a scale formed by the heat and its surrounding material.

The curious are permitted to take samples of material at every step of the process. I took samples of the coke, lime, the mixture, residue from the furnace and of the carbide made. (These samples are on the table for inspection). The final step is measurement of gas made from the carbide. This is done by taking a known number of grammes and measuring the gas coming therefrom when treated with water. Measurement is made, after passing through a condenser, by a wet meter, such as is used in photometrical measurements.

If I have fortunately made myself clear, you all understand fully the process of manufacture, and I will, after showing several slides, briefly discuss the product "calcium carbide."

Calcium carbide is a dense, hard, grayish substance, as already stated, and slakes, on application of water, similar to lime. Its symbol is CaC_2; mol. wt., 64 (weights, 40 parts Ca, 24 parts C). Its specific gravity is about 2.2, and yields, when pure, 5.93 cubic feet of acetylene gas when measured at 60° F. and 30″ bar. Acetylene gas is a colorless gas, with a penetrating and unpleasant odor, having a specific gravity, referred to air, of .91. Its symbol is C_2H_2; mol. wt., 26 (by weights, 24C, 2H). When subjected to a temperature of 32° and a pressure stated at both 21 and 48 atmospheres (316 and 706 pounds), acetylene gas becomes a liquid, of gravity .42 compared with water. The temperature above which the gas ceases to be a liquid is placed at 37.05° C. (99° F.) and 1,000 pounds pressure. When burned in a proper burner, Prof. V. B. Lewes gives the candle power, for 5 feet consumed, at from 240 to 248 candles. These figures have been duplicated by other observers. I shall take this figure as the correct one. Prof. Lewes is the Chief Gas Examiner for the London authorities, and fitted to make the statement.

I wish here to quote from Prof. Lewes, who says: "Illuminating power may be taken as the highest illuminating effect produced by gas without the aid of regeneration or artificial air supply other than that produced by the flame itself. The exact amount of air to prevent smoking gives highest illuminating power." Now, let me quote Mr. Alexander C. Humphreys, M.E. In discussing mixtures of gas and air he says: "The burner should be adjusted to the gas. Some years ago I had occasion to test this matter with Pintsch gas. A full set of experiments was made, and of course I at once saw that while there was a very serious loss, if the same burner was used, there was no such loss with this rich gas as in the case of the 12-candle power coal gas, *i. e.*, a table showed the loss of light, by mixing air with 12-candle power gas, 1 per cent. of air destroying 6 per cent. of the light, and so on up to 40 per cent., destroying all light. By very carefully selecting a burner for each mixture I finally succeeded in mixing in 40 per cent. of air in a 50-candle power gas, and was still able to get as *high* a result per foot of gas used as I obtained by the *unmixed* gas burned in the small burner selected therefor." I quote these words because I want you to understand why it is different experimenters and observers may give different statements, and such statements are correct under their conditions. Before you criticise, ascertain the data, and the contradiction disappears. It requires skill to read candle power with absolute accuracy, and difference in color of flame requires long practice to distinguish. Again, the difference between the candle power of the standard and the gas tested must not be too great. The standard flame recently adopted in England is 10-candle power. The result of this is that in ordinary cases the readings are nearer the center of the bar and the proportional readings on the bar have greater lineal dimensions than is the case with one or two candles as the standard. I have no wish to go into a discussion of illuminating power and yields of gas, but my desire is to point out to you why you hear so many contradictory statements on the subject of acetylene and calcium carbide. Remember, we are in acetylene where the electric light once was. I read criticisms of this gas with more interest than articles in its favor. If they are founded on self-interest or prejudice it appears at once and the article may be thrown aside.

Acetylene is soluble in water. Ten volumes, at 60° F., and 30″ barometer, will absorb 11 volumes C_2H_2. Salt water does not absorb it readily, 100 volumes only absorb 5 volumes C_2H_2, and water that has been used in connection with coal gas does not absorb it readily. If acetylene in liquid state is released suddenly when under pressure it takes a solid state like snow and may be burned from that state by application of a light. A spirit thermometer placed in this snow is said to show a temperature of —118° F. One cubic foot of liquid acetylene would become 400 cubic feet of acetylene gas, if allowed to expand to its volume at normal temperature and pressure; this is only one-fourth what water does in passing to steam. The acetylene flame is placed at 1000° C. (1,830° F.), as against 1,360° C. (2,480° F.) for coal gas. It forms an explosive compound with copper or silver. It is for this reason that the circular to gas fitters of gas companies contains the provision that "No job will be approved in which copper pipe is used."

The accepted formula for the chemical reaction in the furnace is:

$$\underset{(56)}{Ca\,O} + \underset{(36)}{3\,C} = \underset{(64)}{Ca\,C_2} + \underset{(28)}{C\,O}$$

When the calcium carbide is treated with water for forming the acetylene gas the chemical reaction is:

$$\underset{(64)}{Ca\,C_2} + \underset{(36)}{(H_2\,O)_2} = \underset{(26)}{C_2\,H_2} + \underset{(74)}{Ca\,(O\,H)_2}$$

From the above formulæ we conclude that, theoretically, 100 parts by weight of calcium oxide combining with 64.3 parts of carbon will produce 114.3 parts of pure calcium carbide and 50 parts of carbonic oxide. We also see that from 100 parts by weight of pure calcium carbide combining with 56.2 parts of water we should obtain 40.6 parts of acetylene gas and 115.6 parts of calcium hydrate.

We now come to what is perhaps the most interesting part of the subject in hand. That is, the materials used in the manufacture, the power required to perform the work, and other items of expense connected with the development. The calcium carbide itself will only be treated at the moment. We have considered above the theoretical amounts of calcium oxide and carbon. Of course they are not found pure. They use at Spray an excellent quality of lime from Virginia, and coke made from Pocahontas coal. 1.17 parts of lime are used to .83 part of coke, or the coke is 71 per cent. of the lime, in place of 64.3 per cent. as found above to be the theoretical proportions of calcium oxide and carbon. Again, the yield of carbide depends upon the voltage and the materials used as well as other circumstances. And here again great danger for misunderstanding exists. The yield of carbide may be high per one horse power 24 hours, and it may be low; but in the first case it is apt to have a low yield of feet of acetylene per pound of carbide; but the low yield of carbide may mean a very pure carbide, and a high yield of acetylene. The yield of acetylene gas per one horse power 24 hours varies between 48 and 53 cubic feet. It is surprising to find much of the carbide so pure. In the test coming under my personal observation 231 pounds was made in 2½ hours, 5 per cent., or 11.55 pounds, was estimated as slag, and deducted, making 219.5 net pounds made in 2½ hours. I selected a piece of the slag and found 1.6 cubic feet of gas per pound coming from it. It is more convenient to charge off 5 per cent. as having no gas than pursue any other method. The amperage was 1,310 and voltage 100. The net electrical horse power at the point of the movable carbon electrode was 168.6. 219.5 pounds of carbide in 2½ hours is equivalent to 2,107 pounds per day running continuously at this power. The above figures likewise give 12.5 pounds per net electrical horse power 24 hours at the point of the pencil, which is the unit used in the manufacture of carbide at Spray.

The yield of gas from two samples I selected as good carbide (other than the one already mentioned) proved to be 4.19 and 4.44 respectively, giving 4.31 cubic feet as the average. This average, multiplied by 12.5, gives 53.875 cubic feet of gas per each electrical horse power 24 hours. In a test finished immediately before the one given above, the yield of carbide was but 10.35 pounds per one horse power 24 hours, but the yield of gas proved 5.13 cubic feet. The product of these is 53.10 cubic

feet of acetylene per one net electrical horse power 24 hours. This last test was a 3-hour test, at 176 electrical horse power at the pencil. This bears out my statement that the yield of carbide and the yield of gas must both be considered. In making up the cost of manufacture one is confronted with some difficulties. It hardly seems fair to take one test and say that is the average. Again, a plant of this description, which is built on the lines of experimental data, is not properly adjusted as to capacity of parts.

In Spray there is needed a third furnace, not for any use, but to allow carbide to cool and still not interrupt the continuous running of the plant. But movable cars may be used, as proposed at Niagara. I have increased the cost of the plant much beyond the amounts thought to be sufficient by some, but experience leads me to believe it best to give a good structural value in such cases. At the same time I assume a fair yield of carbide and gas therefrom, approximating to that of the two tests that I have personal knowledge of.

The yield assumed is 10.6 pounds of carbide per 1 net electrical horse power exerted 24 hours at the point of the pencil, and yielding 5 cubic feet of gas to the pound, or 53 cubic feet of acetylene gas. I take as the unit capacity of the plant the dynamo capacity, and from that determine the cost for continuous running. At Spray there are three other mills—a cotton, a woolen and a flour mill—on the same canal; the cotton mill built in 1843 by Major Morehead's father, who was at that time Governor of North Carolina. The flour mill was built in 1813 by his grandfather. The presence of these mills prevents the use of full power in the carbide plant except at night, as a penalty for excess water must be paid. But as we wish to arrive at a business proposition, this is not considered. Two 100-killowatts machines (rated at 120) can be counted upon to produce 268 electrical horse power. Crediting the dynamos at 90 per cent. efficiency, there would be required at the dynamo shaft 268 ÷ 90 = 297.8 horse power. We must add sufficient horse power to grind the material. I consider 12.2-horse power net more than an ample allowance in this case. Our horse power is now 297.8 + 12.2 = 310 to be supplied by our prime mover. In this case we have a turbine water wheel. Assuming this class of wheel to have an efficiency of 85 per cent., we have 310 ÷ 85 = 365. This is the horse power we require from the water wheel to give us through the wheel, dynamos, transformer, and to the pencil, for useful work on the carbide, 257 net electrical horse power. The loss is the 365 — 257 = 108. The gross horse power is therefore 141 per cent. of the net electric horse power at the pencil.

The mixture I have stated to be in the proportions of 1.17 parts of lime and .83 part of coke. We have now to consider the labor. Labor is very cheap at Spray, but it is worked in three shifts. The labor is $11.50 a day. The cost of carbons is stated to be $10.80 for a set, and this set, by being protected by mixture as stated, will last for the making of at least 10 tons. Combining this data we have the following:

257 H.P. × 10.6 pounds of carbide give a yield of 2,724 pounds per day of 24 hours. We will assume running continuously 365 days, as is the custom in gas works.

	Per Day.	Per Ton 2,000 lbs.
365 H.P. × $\frac{\$5.00}{365}$ H.P. per year, Water power.....	$5.00	$3.671
2,724 × .83 × $\frac{\$2.75 \text{ ton}}{2,000}$ " Coke.....	3.11	2.283
2,724 × 1.17 × $\frac{\$3.50 \text{ ton}}{2,000}$ " Lime.....	5.58	4.096
$\frac{2,724}{2,000} \times \frac{\$10.80}{10 \text{ tons}}$ " Pencils.....	1.47	1.079
Supplies, oil, waste, etc.....	.50	.367
Labor.....	11.50	8.443
Interest, depreciation and repairs, as per statement below.....	3.84	2.819
	$31.00	$22.75

Electric machinery, $4,000, at 15 pr. ct. dep.	$600
Water wheel, etc., $3,000, at 5 pr. ct. dep...	150
Buildings, etc., $3,000, at 5 pr. ct. dep.....	150
Total, $10,000, at 5 pr. ct. interest.....	500

$1,400 ÷ 365 days = $3.84

The candle power of acetylene has been stated above. When mixed with coal gas, Dr. Wilkinson has stated that at least 2 candle power is obtained for each per cent. of acetylene added to a 15 to 16 candle power coal gas, and that a coal gas may be enriched to from 22 to 23 candle power and give a clear, white light without smoke. The coal gas works, therefore, have within their reach an efficient enriching element with a value not possessed by present methods. Experiments made by reliable authorities show that the same statement is true of water gas, if it is first carbureted to a limited extent by using the present enriching methods and the completing it with acetylene. This would be following the methods pursued by the Equitable Gas Company several years ago; that is, enrich partially in the manufacture of the "blue" water gas, and finish the carbureting with acetylene in place of naphtha in retorts.

The Spray plant could not be enlarged without the construction of a new canal. The freight rates are high, as all material must be shipped via two narrow gauge roads (both in the hands of receivers) to Danville, Va., where all material must be transferred to broad gauge cars of the Southern Railroad, to be shipped to other points. It is not surprising that extension of this plant was not attempted.

The Philadelphia Company, seeking for a source of supply at the shortest notice, located at Niagara. I am indebted to Mr. S. L. Kent, President of the Philadelphia Company, for the following description of this Niagara plant, which I feel sure will interest you as much as it did me:

"The plant of the Philadelphia Carbide Manufacturing Company, now nearing completion at Niagara Falls, New York, is situated on the lands of the Cataract Construction Company, about 1½ miles above the Falls, and receives from the 5,000-horse power generators of this Company 1,000 electrical horse power at a voltage of 2,200, which is transformed, by a special transformer, manufactured by the General Electric Company, to 100 volts, under a guarantee of 97 per cent. efficiency. This transformer is a duplicate of one now in use by the Carborundum Company, at Niagara, also manufactured by the General Electric Company, and these are said to be the largest now in use.

"A water rheostat is used and is located over the switchboard. The cables for each furnace, conveying 500 electrical horse power, connect with a copper rod 3½ inches square, which carries at the lower end the holder, containing six carbon slabs of conical shape forming the pencil, the other end connecting with the carbon raising device, which is regulated by an attendant in the instrument room according to the readings of the meters. The furnaces are built of ordinary brick with opening in front through which the iron crucibles are introduced on a small truck running on tracks leading to the cooling and packing room, the electrical contact being made on the side of the crucible. A flue connects the furnace with a settling chamber of brick with hanging walls for the reception of the material carried off by the carbon monoxide generated in the course of manufacture, which material is used again in the mixture. This chamber is provided with a connection to the stack for the passage of the gases. The furnaces are provided with overhead bins for the prepared mixture, which is received from the crushing room by a conveyer and admitted to the crucibles by shutes controlled by suitable sliding dampers at the will of the furnace attendant.

"The crushing and grinding plant is driven by a 75-horse power electric motor, and consists of a coke crusher, grinder and the necessary mixing, sifting, weighing and conveying machinery; this process being automatic, from the introduction of the coke to the crusher to its introduction to the furnace, except the reading and dumping of the scale during the weighing process. On the completion of a run, the length of which is determined by the limit of vertical movement of the pencil, the crucible is removed to the cooling room and another introduced, when, after completing the electrical contact, the operation is resumed, the change requiring about two minutes. It is expected that by the use of closed furnaces the efficiency of the carbon pencils per ton of carbide produced will be increased, and the product of carbide per electrical horse power greater by the use of a much larger volume of current in one furnace than is the case at the present plant at Spray.

"The output at the beginning will be between 5 and 6 tons per day, using 1,000 electrical horse power, but the furnace room, crushing and grinding plant have a capacity of 25 tons, which can be obtained by the introduction of a corresponding transforming capacity. The labor consists of three electricians, two on 9 and one on a 10-hour shift, who make the chemical analyses and attend to the pay roll and shipping; three attendants in instrument room and four laborers, consisting of three furnace men and one to feed the crushing mill, which runs but a short period each day on a 5-ton output. This plant was designed and erected under the able supervision of Mr. J. M. Morehead, the Engineer of the Electro Gas Company, of New York city."

I have endeavored to place clearly before you certain facts in regard to calcium carbide and acetylene, and of its manufacture. There is other matter in my possession which I am not at liberty at this time to

discuss, but which I hope to do at some future time. Suffice to say that all these facts add new interest to the subject and tend to give an incentive for future careful study of the problem. I will now touch upon a few points that may be of interest. My original intention was to elaborate upon them, but the time at my command forbids it.

If we are to deal with liquid acetylene it is of interest to know what pressures we may expect to meet with. Liquid acetylene has a specific gravity of but .42, water being unity. This is a very low gravity. (Anhydride of valerianic acid, .34 specific gravity; hexyl ether of acetic acid, .389 specific gravity.) I have stated that the temperature above which the liquid becomes a gas, no matter what pressure may be exerted, is about 99° F.—to be more exact, 98.69° F., and that at this temperature the pressure under which the liquid exists is about 1,000 pounds.

Many of you will ask, as I have, without receiving any definite reply, what happens beyond the temperature of 98.69° F.? Let us try and get some idea of what pressure may be obtained after the liquid is gasified, the inclosing volume remaining constant. I have stated that acetylene *gas* has a specific gravity of .91, *air* being unity. You will see that this is not a light gas, as crude coal gas is about .4. With this data we may see, roughly, if the statement that 1 cubic foot of liquid acetylene becomes 400 cubic feet of acetylene gas is true; for this figure is an important one. A cubic foot of water weighs 62.425 pounds; multiplying by .42, the specific gravity of liquid acetylene, we have 26.218 pounds as the weight of 1 cubic foot of acetylene liquid.

The weight of a cubic foot of air at 99° F. is about .0714 pounds; multiplying by .91, the specific gravity of acetylene gas, and we have .064974 as the weight of a cubic foot of acetylene gas. Now, in the transfer from a liquid to a gas we cannot lose weight; therefore, dividing the weight of a cubic foot of liquid acetylene by the weight of a cubic foot of gaseous acetylene, or $\frac{26.218 \text{ pounds}}{.064974 \text{ pounds}}$, and we have 403 cubic feet as the result, which, in a rough way, checks the value I have given you of the relative volumes of 1 to 400. The result would have been exact if the weights at the proper temperatures had been considered. Let us suppose now that we have 400 cubic feet of acetylene at the pressure of 1 atmosphere and at 99° F. How many atmospheres would we have in pressure if we compressed the 400 cubic feet to the space of 1 cubic foot, the temperature remaining constant at 99° F. Under these conditions the pressure times the volume is a constant; therefore, 400 cubic feet × 1 atmosphere pressure = 1 cubic foot × x atmospheres, or, x would be 400 atmospheres, or, 400 × 15 = 6,000 pounds approximately. Additional pressure, we are told, will produce no change in the gas; but let us now cool the 1 cubic foot, at 400 atmospheres should it not become a liquid when the temperature reaches 98.69° F., and the pressure fall from 6,000 pounds to 1,000 pounds? If we reversed this operation with a tank holding exactly 1 cubic foot and filled to that capacity with liquid acetylene, would we have an increase from 1,000 pounds to 6,000 pounds?

We must qualify this question somewhat. If we filled a tank at 32° with liquid acetylene we undoubtedly would get a very high pressure. But this would never occur in practice. The tank would be filled at the highest temperature that it would liquefy at. A photograph of the apparatus proposed indicates that this is so. As a further illustration, take carbonic acid gas:

Pressure at 32.00° F.	is 35.4	atmospheres.	
" 77.00° F.	is 66.	"	(Regnault.)
" 86.00° F.	is 71.	"	(Regnault.)
" 87.62° F.	is 74.	"	(Andrews.) Critical temp.
" 95.00° F.	is 82.	"	(Regnault.)
Specific gravity 32° F			.83
" " 72° F			.726
" " 86° F			.60

In this case we pass the critical temperature and go beyond it, and the pressure is increased 82 — 74 = 8 atmospheres, or a little more than 10 per cent., or from 1,110 pounds, at 87.62°, the critical temperature, to 1,230 pounds at 95°. The decrease in the specific gravity at the higher temperatures is very marked, and the number of pounds per cubic feet of carbonic acid decreases nearly 30 per cent. between 32° and 86°; therefore the relative volumes of liquid and gas decrease. But carbonic acid gas is a very heavy gas, and the analogy between acetylene and this gas, for that and other reasons, is not a good one except as regards the temperature of its critical point.

But some such action probably takes place in the case of acetylene. Any change would not be sudden, and, therefore, the pressure should be considered as a dead load. Considerable heat is probably necessary to produce this change from liquid to gas, as note that required to change water to steam in the table below:

		Saturated Steam.	Northcott Steam Engine, Table IV.	
Pressure	lbs. sq. inch	14.7	170.	300.
	" " foot	2116.8	24480.	43.2
	atmospheres	1.	11.6	20.4
Boiling Point	Degrees Fahr	212.	368.3	417.1
	Absolute	673.2	829.5	878.3
Volume	Comp. with H_2O	1644.	166.	97.
	Cu. ft. per lb	26.36	2.657	1.5653
(*a*) Heat to raise 1 lb. from 32°F. to boiling point		180.52	340.02	390.72
(*b*) Heat absorbed per lb. overcoming int. resistance of vaporization		893.81	770.	730.85
(*c*) Heat disappearing per 1 lb. in overcoming ext. resistance to expansion		72.27	84.25	87.59
(*d*) Latent heat of vaporization per lb. constant pressure		966.08	854.25	818.44
(*e*) Total heat per lb. water at 32° to steam constant pressure		1146.60	1194.27	1209.16

I would remind you also of the experiments made in liquefying oxygen. You may remember that the cylinder then used was constructed to withstand 1,500 atmospheres or 22,500 pounds. In liquefying oxygen, just before liquefaction the pressure was observed to be 500 atmospheres, about 7,500 pounds, and during liquefaction the pressure was observed to fall as low as 320 atmospheres, or 4,800 pounds. The pressure after gasification, as compared with that as a liquid, depends upon the relative volumes before and after gasification and upon the pressure before gasification. If this bears a certain relation the pressure as a liquid and as a gas would be the same. In order to prevent a great pressure it is only necessary to fill but a portion of any cylinder with the liquid, at a temperature near the critical temperature. After gasification, acetylene would increase in pressure as any other gas under similar circumstances. It would seem that if the figures given above for carbonic acid are even approximately correct for acetylene, that tanks tested to 4,000 pounds are strong enough for the possibilities, but I would suggest that the members of this Association should study the subject carefully, if they desire to handle this material in liquid form, under all conditions possible and probable.

All this discussion is tentative. It is an open question in my mind if it would be possible to gasify liquid acetylene accidentally under normal conditions met with in practice, outside of accident of fire or similar conditions; some excess space should be allowed above the liquid material in any cylinder for expansion. Any cylinder with gas and a closed outlet must sooner or latter give way through the combination of increase of pressure of the gas due to excessive temperature and weakening of the material of the cylinder from the same cause.

For some time past I have had Dr. J. F. Wing, Ph. D., one of my assistants, making a series of experiments that would interest more particularly the gas manager. But little other than preliminary work has been accomplished so far. I will give some figures attained, and then pass on to the consideration of some heat computations. Acetylene was absorbed by and driven out from the following materials as stated:

		Vols.	Vols. C_2H_2	Temp.	Mercury.
*Salt water,	33 per cent. salt	100	absorbed	36.2 at 75° F.	and 30″
"	33 " "	100	"	40.1 at 74° F.	" 39½″
"	33 " "	100	"	53.9 at 64° F.	" 42″
Machinery oil		100	"	118.0 at 58° F.	" 30″
(*a*) Distilled water		100	"	104.4 at 62° F.	" 30″
" "		100	"	104.9 at 63° F.	" 30″
(*b*) " "		100	"	105.1 at 63° F.	" 30″

* Salt water has normally 3 per cent. salt.

		Per cent.	Temp.	
(*a*)	C_2H_2 driven out of distilled water	55	at 160° F.	in 6 hours.
	" " " " "	69	at 190° F.	in 2 "
(*b*)	" " " " "	34	at 100° F.	in 3 "

Ash in gas coke 12 per cent. (Pocahontas coal, coke but 8 per cent.)
One pound 85 per cent. pure carbide yields 756 B. T. U in slacking.
This is about 1¼ times heat of lime in slacking.
Samples of carbide yielded as high as 5.1 cubic feet.
The average tested yielded 4.65 feet per pound.

The candle power, up to February 13th, indicated 182, but since that time a burner has given promise of 225-candle power. The illuminating value of mixtures of coal gas and acetylene gas have been made from 18-candle power to 29 candles, but the results are not yet definitely settled. Pending the completion of results I would refer you to Prof. Lewes' published results and to statements by Dr. Wilkinson, Dr. Love and others.

An excellent feature in acetylene is that increase in pressure does not seem to deteriorate the light; thus 3″ pressure, passing 1.35 cubic feet gas, gave 206.4 candle power; 4″ pressure, passing 1.64 cubic feet,

gave 207.4, a slight increase. It is hard to blow out the acetylene flame. Let us consider now the electric power required to make calcium carbide, repeating the formula:

$$\underset{(56)}{Ca\,O} + \underset{(36)}{3\,C} = \underset{(64)}{Ca\,C_2} + \underset{(28)}{C\,O}$$

Heat required:

Disassociation of CaO (Julius Thompson).....	—131.7 Cals.
Formation CaC_2, *Comptes Rendus*, No. 120, p. 482 (Forcrand).....	— .65 "
	—132.35
Association of CO yields.....	+ 28.6
Net heat required.....	—103.75 for 64 grm.

$$103.75 \text{ cal.} \times \frac{1{,}000}{64} = 1{,}621.1 \text{ cal. for 1 kilogr. (2.2 pounds) } Ca\,C_2.$$

$$(746 \text{ watts}) = 647.7 \text{ cals.} \therefore \frac{1{,}621.1}{647.7} = 2.50 \text{ E. H. P. per kilogram, or}$$

1.13 E. H. P. per pound.

To raise CaO from 0° to 3,000° C. requires:

$.0108 \text{ cals.} \times 3{,}000° = -32.40$ cal.

$$32.40 \times \frac{1{,}000}{64} = 506.2 \text{ cals. for 1 kilogramme (2.2 pounds) } CaC_2.$$

$$\frac{506.2}{647.7} = .78 \text{ H.P. per kilo—or .35 E.H.P. per pound } CaC_2.$$

1.113 + .35 = 1.48 E.H.P. per pound of carbide *pure* of 5.94 cubic feet. C_2H_2 at 60° F. and 30" mercury, or 5.53 cubic feet at 32° F.

(*Note.*—1 cal. = 3.96 B.H.U. $\therefore$ 1 H.P. $= \frac{33{,}000 \times 60}{772} \times 3.96 = 647.7$ cal.)

24 E.H.P. should produce 16.22 pounds pure carbide.

Again, consider now the two formulæ:

$(CaO + 3C = CaC_2 + CO.)$

$(CO + CaC_2) + (H_2O)_2 = C_2H_2 + Ca\,(OH)_2 + CO.$

Heat obtained:

CaC_2 slacked to form C_2H_2 yields..	30.15 cal.*	
Burning C_2H_2 yields	315.70	
		345.85
Burning CO yields.....		68.20
		414.05

* Dr. Wing finds this figure to be 30.70.

We obtained from the—

$CaO + H_2O = Ca\,(OH)_2$.....	18.1	
$3C + 3O_2 = 3CO_2$.....	290.88	308.98
		105.27

Note.—There has been considerable discussion in regard to the heat value from burning acetylene—Thompson gives 310.60. If it were 313.70, then our result (105.27) would become 103.75, or the electric energy put into the process, as determined by the preceding paragraph. We see from above that the heat of slacking is nearly 10 per cent. of the heat of the gas burning, and this amount (30.15) is equivalent to

$$30.15 \times \frac{1{,}000}{64} \times \frac{2.2 \times 1.8}{2.2} = 848.25 \text{ B.H.U. per pound of carbide treated with water.}$$

From this last figure it will be seen that if acetylene gas is manufactured and distributed pure through our streets, in the manufacture a great deal of water will be evaporated and must be condensed before the gas is allowed to flow to the gas mains, and the mains must be furnished with the same drips used for the present commercial gas, for this reason, if for no other. It is not my purpose in presenting this paper to do other than place before you such facts as I was interested in obtaining myself. I have tried to give the steps leading to any result so that each of you may, with your own conditions and data, figure out your own results. Any parts that I may have omitted you may readily supply yourselves. I should have been glad to have reported to you the number of cubic feet of gas made from an entire ingot of carbide, made with a certain electric horse power, but the facilities for performing this important experimental step were lacking. This, with a further demonstration of electric power per pound of material, will take us further from the experimental stage. I do not propose to go into the details of candle power per unit expenditure; all this you have doubtless already considered.

Now, let us assume that we all want carbide of calcium for the sake of the gases obtainable therefrom; how are we to make it? We are all doubtless looking towards the Niagara Falls plant, of which I have, through the kindness of Mr. Kent, shown you the photographs. This plant is five times as large as that at Spray, and I understand that it will be running by the 1st of March.

In making carbide, the use of water power would seem to be a natural selection. Streams running at low power in summer as compared with the winter flow would probably not be as unprofitable in this industry as when used for other manufacturing purposes, for the uses of calcium carbide would be a maximum in December and a minimum in July. Probably these months would mark the maximum and minimum flow of water in such streams. The use of the idle power of the electric light plants should be considered. To be sure, the machinery may not be suitable at present, but we can trust our electric friends to construct apparatus that will prove efficient in the end. This idle power forms a large proportion (over 50 per cent.) of the total horse power. The electric roads may be another possible source of power.

Now, as to the cost of power from these plants. You must remember one fact in connection with any such costs. They are doubtless the average for an entire year, under all conditions of running—full power, two thirds, one-half, one-quarter, etc. The question we must have answered is, What is the cost under the present conditions, and what would be the cost if the plant were run continuously at full power, if the surplus beyond the present needs of the plant is utilized in the manufacture of carbide? The spare capacity would be least in winter, which would be unfavorable; but I am led to believe that carbide may be stored as readily and safely as any material used for similar purposes, and should this prove true such plants might be utilized all the year round. In connection with the question of efficiency of electric lighting plants, I would like to place before you the following figures, which I feel convinced are reliable:

If (A) represents the number of pounds of steam used per indicated horse power at full output, then the number of pounds of steam per electrical horse power, at full output, and the same figures at one-quarter output, are given. Thus, engines, triple expansion:

Full output—	Pounds of steam per	indicated	horse power....	A
"	"	"	"	electrical	"	....1.15 A
Quarter	"	"	"	indicated	"	....1.15 A
"	"	"	"	electrical	"	....1.88 A

It shows clearly the great loss of electric efficiency. This is doubtless now reduced by the use of storage batteries. Gas companies with surplus coke may possibly be able to utilize it in the manufacture of carbide, but the prime mover must be selected.

This subject would require another paper to deal with it in the most elementary way. I would suggest to those members who desire to go into the subject that they consult the following papers:

"Comparative Cost of Steam and Water Powers," by Charles H. Manning, U.S.N., Manchester, N. H.; Transactions of the Am. Soc. Mech. Engrs., Vol. X., p. 499.

"On the Use of Compound Engines for Manufacturing Purposes," by Charles T. Main, M.E., Lawrence, Mass.; Transactions of the Am. Soc. Mech. Engrs., Vol. X., p. 48.

"Selections of Motive Power," by C. E. Emery, M.E.; AMERICAN GAS LIGHT JOURNAL, Vol. LXII., pp. 6, 185.

The files of the GAS JOURNALS will prove profitable reading, if the members have not kept in touch with carbide from week to week. Let me again suggest that this subject be not allowed to rest until the whole matter is thoroughly sifted, so that the gas companies may reap any benefits to be derived from any discoveries or developments in the manufacture and use of calcium carbide.

Discussion.

The President—We have heard a very interesting paper. I think Mr. Addicks may feel that it has been appreciated, by the close attention with which this large audience listened to its reading. I trust you will use up what remains of the afternoon in the discussion of the subjects of carbide of calcium and acetylene. Mr. Addicks is ready to answer any questions, and shall be glad to have the discussion go on. I have no doubt there are many here who desire to talk on this matter, and I hope that you will commence at once in order to utilize the time.

Mr. Taber—To set the ball in motion: I understood, Mr. President, from part of your able address this morning that it was now proposed to give up the idea of distributing this gas by means of liquid acetylene, but rather to distribute it from independent centers, or from small isolated stations. Will that be possible under existing conditions, and with this necessity for constant care with regard to it; and will it not also prove a source of extra danger, since so many people will have the handling of it?

Mr. Addicks—Do you refer to the acetylene cylinders?

Mr. Taber—Yes; is it not thought better to discontinue that practice?

Mr, Addicks—I cannot answer as to that. I do not in my paper intend to convey the idea that I was particularly favorable to the use of cylinders. In the explosion at New Haven it would seem that the dissociation of the carbon and hydrogen took place. I did not treat of that; but Prof. Crafts stated about two weeks ago (I speak from memory), that, under those circumstances, a pressure of 20,000 pounds per square inch would be obtained. That is to say, any cylinder marked 4,000 pounds, or about that, would not be sufficient to take care of that pressure.

The President—It has been frequently stated that the U. G. I. Co. investigated the calcium carbide question; perhaps Mr. Walton Clark will answer some questions, or give us some information about the subject.

Mr. Clark—We have certainly investigated the subject, but I have no figures with me, nor any in mind which I can state; but, so far as relates to the enriching value of acetylene, I remember that the addition of 1 per cent. of acetylene gas to coal gas gave an enrichment of about 1½ candles. With the blue water gas it requires a very large addition of acetylene to get any candle power at all—I think it is necessary to add 15 per cent. of acetylene before you get 1-candle power; but after that, of course, the enriching value of the 15 per cent. addition rises very rapidly.

The President—Is Mr. Hinman here? Here is another chance for him to discuss candle power.

Mr. Hinman—I have no figures with me at present.

The President—We shall be very glad to have you say anything about acetylene gas. Or will Mr. Nettleton give us some facts? I would like to have quite an earnest discussion of this paper. Mr. Addicks has covered the ground in his usual careful manner. Where he undertakes an experiment, we know he will go at it in a thorough and exhaustive manner. This case has been no exception to the usual rule. The paper has been carefully prepared and has given us much that we all wanted to know on this interesting subject. Many gentlemen are experimenting with the carbide and with the gas, and their views may differ somewhat from those of Mr. Addicks. I hope such gentlemen will give their own figures, and also ask Mr. Addicks questions. For instance, members of the Association have different views on this question of pressure on cylinders. I have heard that question discussed several times within the last few days—the pressure on the cylinder, and the danger if you go beyond a particular point with the liquefied acetylene. Mr. Addicks gives that to us as 6,000 pounds. Some gentlemen say that it is below 6,000, while others say it is much more than that. I simply speak of this one point so as to show that there is a difference of opinion. Many figures are being made, and many chemists are at work upon carbide of calcium and acetylene gas, and for the time being it is practically out of the hands of gas men and in the hands of experts; but here is a chance to get data from a man who has been spending a very large amount of time in the investigation. I hope if any of you have questions you will not be backward in asking them. I know that Mr. Coggshall is a man who had more or less experience with this company in Boston, who wanted him to buy it right away. I don't know whether or not he has the deed of sale in his pocket; but I know we would all like to hear from him.

Mr. Coggshall—I have not.

Mr. Nettleton—A large element in the cost of carbide of calcium is the cost of the power employed. In the figures Mr. Addicks has given the cost of water power is stated at $5 per day of 24 hours for over 300 horse power. Converting this into cost per horse power, and assuming the amount employed to be 300, the cost will be $2.50 per horse power for 12 hours per day, for 300 days in the year. I do not believe that any water power can be built where this rate of payment will make a fair return on the investment in land, dams and canals. I think that the cost of water power varies in different localities from five to ten times that amount; and multiplying the cost of power, as given by Mr. Addicks, by either five or ten, raises the cost of the carbide very materially.

Mr. Coggshall—I would like to ask Mr. Addicks a question of interest to all gas men—although perhaps he is not prepared to answer it—as to the practicability of the use of acetylene as an enricher; whether it has been developed sufficiently to determine how it can best be used in connection with coal gas?

Mr. Addicks—I will answer by saying that, so far as we are concerned, we simply use it experimentally, and in the same way in which a number of other gentlemen have used it.

Mr. Coggshall—But not yet on a practical scale?

Mr. Addicks—Not at all.

Mr. Clark—I apprehend it will be of interest to one who proposes to use the carbide to know, not what it costs at Spray, with the water power at a minimum expense, but what it will cost at his own gas works, and what he will be able to get out of a pound of carbide when it gets there. An item that Mr. Addicks did not touch upon is the freight. If we must transport the carbide in air-tight packages, we must take into consideration the expense of returning those cases to the point of shipment. In other words, I think that, in order to be practically used in gas works, the carbide of calcium must be made at or near the gas works. The cost of the carbide will depend, not upon the cost of power furnished by water, but upon the cost of power generated from coal. We can carry the coal in open cars, and without any special means of protection, and although the car has to go back, there is no package other than the car. Freight will always, and necessarily, be much cheaper on coal than it will be on the carbide of calcium, and there will be no risk from the generation of gas while in transit. It would be a matter of interest if Mr. Addicks could tell us what the cost of the transportation of carbide is estimated to be by those people who are proposing to manufacture it at Niagara Falls; or, if any one who is familiar with the cost of steam plants will tell us, on Mr. Addicks' figures, what it will cost to generate it from a steam plant in Massachusetts.

Mr. Addicks—Answering Mr. Clark, I can not state what the freight will be, but I have an impression that it will be between $2 and $3 per ton. I understand, however, that from Spray at the present time it is $8 per ton. It is necessary to transport it over two narrow gauge roads, both in the hands of receivers, and reship it over the Southern and other roads to New York. In the table of cost I was careful to give all the details. You can supply any other data you please, and you can ascertain, I think, from what I have given and from what you can supply, within reasonable limits, what the carbide will cost you under given conditions. I notice that Mr. McGeorge, of the Acetylene Company, is in the room, and he can probably tell us something about the Niagara plant, and about the cost of transportation.

The President—Will Mr. McGeorge tell us something about the plant at Niagara?

Mr. McGeorge—I do not think I can tell you anything in addition to what Mr. Addicks has stated, except that the works will be ready to go into operation as soon as the General Electric Company furnishes the new electrical machinery. I will say that we asked for freight rates from Niagara to Boston, and were given 16 cents per 100, or $3.20 per ton. I will also say that the calcium carbide has been shipped several hundred miles, to my knowledge—not contained in airtight packages, but in ordinary old oil or spirit barrels; and in one case the bung was so carelessly put in that it fell out in transit, and there did not seem to be any trouble. Of course it will require a little more careful packing than coal. I have heard the suggestion made by those who are familiar with the article that it will probably be shipped in casks, and that there will be but very slight loss. It has been figured that the loss will be about 1½ per cent., allowing for different conditions of atmospheric moisture. Of course, if you are going to ship your casks in a driving rain, the loss will probably go over 1½ per cent.; but that rain will also so swell your casks that after a little while very little moisture will get through, so that becomes as broad as it is long. If there are any other questions that I can answer I shall be glad to do so.

The President—When is it likely that the Niagara plant will be started?

Mr. McGeorge—It depends entirely upon the General Electric Company. They have promised our machinery within ten days. You can figure on that as closely as I can.

Mr. Taber—The question asked by Mr. Clark was as to what the cost of the carbide would be if it was developed right alongside of the gas works, and by steam machinery; or, in other words, by bringing the water power right close to the door and using it as a steam engine. If we take the best figure we get from millwork, of about $22 or $23 per horse power on the basis of 3,000 hours in a year, and insert that figure into the figures given by Mr. Addicks in place of the $5 per horse power per day of 24 hours, omitting the cost of additional labor even, it would increase the cost, as he gave it, from $32.76 to $53.72 per ton, which I think is about the price that gas engineers will have to pay for calcium carbide made here in New England.

The President—When in New York last week, at the meeting of the Society of Gas Lighting, Captain White made a statement of a talk he had had with a member of the Electro Gas Company. We might ask him to make a simple statement of that in answer to the question as to the practicability of the delivery of acetylene gas from small stations, or small works, through small pipes in the street.

Capt. White—To what extent the conversation which I had with a prominent member of the Electro Gas Company, of New York, might

be considered a confidential one I am somewhat in doubt. Of course, in speaking before the Society of Gas Lighting, where we have no reporter, I felt somewhat more at liberty to repeat the conversation which I had that morning. However, the facts were simply these: I happened to meet this gentleman on the elevated train, and the conversation, from one subject to another, drifted into a discussion of this much mooted acetylene gas and the method of handling it, and what his company deemed would be the finally adopted way for handling the gas as a commercial product. You will all remember that what for a time appeared to be one of the largest bombshells ever thrown into our gas camp was the liquid acetylene and its possibilities, it being said that it was to be carted around in packages like soda water cylinders, to be put into the cellars of our houses, and that we were all going to have this most beautiful light, and have it in a most economical way, for everybody was to be his own gas engineer. Therefore it was very much to my surprise and astonishment that my friend went on to say that they had practically abandoned that idea, and that the future of acetylene gas was in distributing it as a gas, just the same as we do with our own product. He elaborated this (and I thought very forcibly) from this fact: It required very small mains; that practically your city could be divided into districts, or a block system introduced, some cheap place taken, a small apparatus put in there (for this requires only a very small apparatus), and gas made for that immediate neighborhood and distributed through pipes; and, there being practically little or no condensation, the pipes could be laid shallow, wherefore the whole plant would be a very cheap thing. That seemed to be an improvement that would be the natural outcome of this agitation; and that the gas companies of the country might, in looking for competition, expect the introduction of acetylene as a gas, rather than in its liquefied form. It has seemed to me, in listening to Mr. Addicks' paper—and, of course, it is unnecessary to say that a paper coming from that source would be an exhaustive one and would command attention from its perfect character and exactness of detail—that, after all is said, the most important fact for us to consider is the cost of the carbide of calcium. Until we know that *exactly*, we are simply dealing with a ghost, frightful in story and fancy, but not so dangerous when you come to apply scientific knowledge and the cold facts to its dissection. There may be a price at which this gas will be useful to us in our business as an illuminant for our gas, and possibly it may become the gas itself. But whatever may be our excursions into the realms of the ideal, we come back again to the simple fact that it all depends upon the cost of the crude material. And there is nothing in the subject, as yet, for us to fret about. There is no reason why we should lie awake a moment at night worrying about it. It is the old, old story. Ever since our fathers started in this business it has been threatened, from year to year, with sudden extinction because of some new discovery. But we are still here. We have not been extinguished! We are making to-day the best and cheapest light the world has ever seen—prompted and spurred to it by these wonderful discoveries I will admit. And our friends who discovered the wonderful ability of the carbide of calcium to give us acetylene and to make this beautiful light knew that there was a body of intelligent men scattered all over the world who would naturally be their first customers the moment they showed them that they had something worthy of our attention. I feel that it is perfectly safe for us to let this matter rest where it is now—in the hands of those skillful men among us who are giving their time and attention to it, and to the equally skillful men who, owning or controlling these patents, are also devoting their time and attention to its development. They are not foolish men by any means. They are busily engaged in the development of their enterprise, because they know that the moment they put the carbide within our reach we are going to have it. It will not be controlled by opposition companies; there will simply be the old gas companies making the new gas. It is the old story of our history from first to last. Therefore, you and I have no occasion for anxiety as to the result of the efforts of those who are devoting their time and skill to this subject; we can cordially thank them for this attention, and simply wait and watch them while they go on and study the subject for us. We are busy men. Not many of us can give our time to such study. We are, therefore, grateful to those who can and do give up their time and make patient investigation for our general benefit. We are just so many watchful engineers on the watch towers of our profession; and they are on the outside, trying to get their reward from the profession. I think we can safely rest secure in the evening of our days, knowing that our pickets are alert, and that we can trust the outer guard to alarm the camp the moment any danger threatens or good results are promised us from the use of carbide of calcium in gas making. (Applause.)

Mr. Coggshall—I move the thanks of this Association to Mr. Addicks for his valuable, interesting and elaborate paper. We all can appreciate somewhat the great amount of work he has put upon it. [Adopted.]

The Association then adjourned to Friday, Feb. 21st, 1896, at 10:30 A.M.

(To be Continued.)

[Translated for the JOURNAL, by Mr. Fred. Egner.]

Statistical Studies Concerning Labor Conditions.[1]

Under the above heading Herr Director H. Schneider, of Cottbus, presented an exhaustive, thoughtful paper at the annual meeting of the "Maerkischen Society of Gas and Water Engineers," held at Dessau, Germany, during the year, 1895, which was published in the February 5th issue of the *Journal für Gasbeleuchtung und Wasserversorgung*, the "official organ" of the German Society of Gas and Water Engineers. The main object of the author was to prepare, in conformity with a request from the Directory of the gas works, statistics concerning sickness among the employees of the gas works at Cottbus, which the author of said paper describes as a thriving manufacturing town, with about 41,000 inhabitants, of whom some 10,000 males, 4,000 females, and many children, are employed in the local manufactories of textile fabrics. He wanted also to show that employment in the gas industry was not more unhealthful than work at other branches of labor, the affirmative of which question had been asserted to be the case in certain quarters.

With a thoroughness peculiarly German, Herr Schneider completed his task, extending his researches over a period of 32 years; and the results, with a graphical table illustrative of his subject, and a number of tables accompanying the same, nearly fill four pages of the journal named in an interesting manner. Thinking that a summary of the results, as found by Herr Schneider, would be of interest to the non-German speaking readers of this JOURNAL, the principal items are herewith appended. The wages paid are considered (by the author of the paper) fair, considering the work done, and are described as satisfactory to the men. The amounts are as follows:

Stokers, per shift of 12 hours	54.74 cents.
Yard laborers, per hour	4.76 "
Mechanics, per hour	from 5.95 to 8.33 "
Leaders and machinists, per day,	from 64.20 to 78.50[2] "

Although the amounts are no doubt, as stated, satisfactory to the German workingman *in Germany*, and in that country entirely sufficient for his wants—going probably as far in purchasing power as the higher wages paid in this country—yet it is something to be remembered, when the fellow who has travelled in foreign countries comes along and enlarges upon how cheap gas is over there, compared with what it is at home. The comparison could easily be carried further, but as that would be wandering altogether too far from our subject, let us continue. As evidence that the men are entirely satisfied with their wages, Herr Schneider mentions that workmen have been with the Company from 10 to 30 years continuously, and no complaints have ever been made as to the wages received.

In the course of his investigation, Herr Schneider gave the 8-hour, instead of the 12 hour, shift a trial, but found that the production of gas from a like quantity of coal fell off 5.68 per cent. during the former, and the latter system was resumed. He remarks: "When I complained that the heats in the benches were reduced, one shift would lay the blame on the others. Frequently, some of the men on the night shift would not appear at all; and it was difficult to find substitutes at that late hour." "How often have I seen," continues the author, "that men who quit work at 2 P.M., after an 8-hour shift, would wend their way homeward with an uncertain gait not until a late hour in the evening. They had spent their leisure hours in a most worthy (?) manner. Men who had until then led a steady life, now commenced drinking; and quarrels and dissensions entered formerly peaceful families; and, since by reason of financial causes, the same wages could not be given for 8-hours', as had been paid for 12-hours work, the laborers themselves were not at all enthusiastic on behalf of the 8-hour shift, which was discontinued because of these reasons, and the 12-hour shift resumed." This experience of Herr Schneider is as near like as can be to a similar experience of the writer of these lines, who during the past winter also gave the 8-hour shift a most fair and impartial trial in this little American city, of about the same number of inhabitants as German Cottbus, and it illustrates in a most forcible and

1. With especial reference to retort house labor.

2. Fancy offering such to our men. We are obliged to pay four and more times as much for like work.—F.E.

remarkable manner, that human nature is the same, under like conditions, everywhere. Owing to the hard times, the Company, thinking to employ as many men as possible for the winter, consented to a trial of the 8 hour system in the retort house. No coal gas had been made for several years, and hence there was no old prejudice to overcome. The wages paid were 20 per cent. better than laborers could earn at outside work for a full day of 10 hours. But the writer's experience was almost identical with that of Herr Schnieder—only we tried the 8-hour shift three times as long as he did, but with the like general and final result. Strangely enough, we produced about the same amount of gas in the same period of time, and per man, as was done in the German city. During the six years, from 1889 to 1895, Cottbus produced 370,026,000 cubic feet of gas, and about 20,000 cubic feet per day, for each man employed in the retort house exclusively.

During the same six years, Herr Schneider found that the average time lost through sickness by the men was 1.70 day to 100 days. The average for the whole period of 32 years was 1.45 days of sickness to 100 days worked. Comparing these figures with like statistics taken for the past ten years in other branches of labor, he finds the following:

Time lost per each 100 *days worked by the following vocations:*

Clothmakers and weavers	2.24
Iron workers	1.67
Stonecutters, masons and carpenters	1.21
Butchers, bakers and confectioners	1.54
Shoemakers and tailors	3.56
Turners and cabinetmakers	1.30

Herr Schneider also notes that among retort house men the eyes become weaker after the 45th year of age; and concludes with the remark that, while retort house work is by no means a pleasant occupation, as no doubt his colleagues would admit, yet it is certainly not the worst. And he calls on his fellow-members to try as much as possible to show their workingmen that they are their friends, by doing all they can toward that end, and to demonstrate the error of certain labor agitators, whose shibboleth is "As little work and as high wages as possible. If we do this we then have done our duty."

Incidentally, Herr Schneider shows in his "graphic illustration" that the dullness of trade was quite marked in his section of the world—the same as here—and that there was a slight, though marked, falling off in gas sold, owing to the introduction of the incandescent gas burners; but there is now again an improvement in that matter to be noted. On the whole, it is hoped that this review of Herr Schneider's paper may be as interesting, instructive and profitable to the reader as the original was to the reviewer of these lines.

Notes on Carbon Bricks in Blast Furnaces.

At the Pittsburgh meeting of the American Institute of Mining Engineers Dr. R. W. Raymond had this to say:

In connection with the discussion of the paper of Mr. James Gayley, presented at the Baltimore meeting, in February, 1892, on the "Preservation of the Hearth and Bosh Walls of the Blast Furnace," I offered a translation of a letter received from our distinguished honorary member, Prof. P. Ritter von Tunner, concerning the use of carbon bricks at the Donawitz furnace, then (February, 1892) in the third month of its campaign. The purpose of this brief paper is to put upon record later results of practice with carbon bricks, both in this country and abroad.

Before doing this, however, I wish to correct an error in my translation of Prof. Tunner's communication, to which my attention has been called in the course of later correspondence. Namely, I was misled by some incidental phrases employed by him to conclude that the whole of the Donawitz furnace, above as well as below the boshes, was lined with carbon bricks. Later information has shown me that this was not the case, and that the "upper" and "lower" linings of carbon brick, then understood by me as respectively above and below the bosh line, were intended to mean the lining of the hearth or crucible, above and below the tuyeres. Prof. Tunner's reference to the abrasive action of descending material must therefore be understood as referring to the walls of the smelting space above the tuyeres. I make this correction because I think it should never be deemed too late to confess and rectify errors in our *Transactions*. So far as I am now aware, this particular error has not had, and may not have, any important effect. Yet it is well, by correcting it, to put on record the fact (which I have ascertained also by direct correspondence with experts abroad) that carbon bricks have not been employed hitherto, in Germany or Austria, for the lining of the whole of a blast furnace. The question, therefore, whether they could be so manufactured as to be superior to chamotte bricks (*i. e.*, ordinary firebricks) or other materials, for the lining above the boshes, is one concerning which no light is offered by foreign experience.

With this explanation, I proceed to give the latest information (November, 1895), concerning the Donawitz furnace, for which I am indebted to the management, through the courteous intervention of our honorary member, Prof. Hanns Hoefer, of Leoben, Styria,

According to this statement, the carbon bricks lining the hearth were laid within a strong iron mantle. The thickness of the hearth wall was 1 meter, in two interlocking layers of 600 and 400 millimeters respectively. The mortar consisted of three parts coke and one part clay. Before blowing in, the carbon bricks were protected against burning during the heating up with a 150-mm. layer of chamotte bricks. The bottom of the hearth was made of chamotte bricks. The furnace has now run four years, with an average annual product of 55,000 tons. The carbon bricks are still tolerably long (over 700 mm.), and justify the expectation of a considerable campaign yet to come.

Mr. James Gayley advises me that there is nothing new to be added on the subject from experience at the Edgar Thomson furnaces. There is at these works one furnace with carbon bricks in the bosh wall, which was put in blast in 1893, and is still running and giving satisfactory results. The commercial value of the carbon bricks, however, cannot be determined until the blast is ended, when it will be possible to compare the advantages resulting from their use with the extra cost involved. Pending such determination, the company is not using these bricks in other furnaces.

Mr. J. M. Somerville on Gas Burners.

Mr. J. M. Somerville, Chemist to the South Metropolitan Gas Company of London, some weeks ago lectured on "Gas Burners" before the Gas Engineering Society—a Society recently organized in London. Our abstract of his remarks is from the London *Journal:*

The lecture was illustrated by a number of burners. These were fixed, according to their chronological order, on a length of gas piping, and so demonstrated the gradual progress that had been made from the punctured thimble to the Welsbach incandescent gas light. As Mr. Somerville proceeded, the burners were shown alight, and some interesting comparisons were effected. The gas issuing from the perforated thimble was first lighted, and then that from a short tube on which was an iron cap containing a series of fine holes. The lecturer explained that Murdoch was led to adopt the latter when contemplating the lighting of the Soho Works, by the accidental capping by a thimble of the flame issuing from a gas pipe. The first burner to come into general use consisted of three rat-tail flames; and this was commonly called the Fleur de Lys. In improving this, Murdoch arrived at a burner which was a kind of comb, possessing a number of orifices close together, but with quite distinct jets. In the course of his lecture (and it may be conveniently mentioned here), Mr. Somerville referred to Williams and Dean's[1] burner as a curious instance of "history repeating itself" in relation to the last mentioned burner devised by Murdoch. It is a combination arrangement; and in the steatite tip of the cap there is a row of very fine holes, giving, of course, an unbroken flame, but the jets can be distinctly traced. The iron burner, with the thin slit, next came in for notice. Drawing attention to the section of the burner, Mr. Somerville pointed to the enlargement of the head at the orifice, remarking that the increase of material at this point allows of the retention of a portion of the heat of the flame and consequently helps, although slightly in this case, in the combustion of the gas.

The next advance was the flat-flame burner with clay or steatite tips, which readily receive and retain a very high temperature, and this was taken advantage of in Sugg's table-top burners. But these various burners must have the proper pressure supplied to them, in order to obtain their full effect with regard to consumption. This brought Mr. Somerville to the question of automatic governor burners, of which he showed Mr. Sugg's "Vincent" as a good example. Some little time was spent in illustrating the action of these governors, by the aid of a burner with a glass body.

Passing to the Argand burner, the lecturer described its construction, and reference was made to its use for photometrical purposes. A noticeable feature of the burner, said the lecturer, is the immediate and almost regular increase and decrease of illuminating power of the gas. There is a slight disadvantage in the form of the burner when dealing with a gas of low illuminating power, owing to the supply of air being more than is required, which results in the cooling of the flame. For instance, dealing with 15-candle gas, a flame is given some-

1. See JOURNAL, Jan. 13, p. 50.

what less in height than with 16-candle gas with the prescribed consumption of 5 cubic feet per hour. Adjusting the flame to the height for a 16-candle gas, taking the increased consumption and working the result out proportionately, a value of 15.5 or 15.6 candles is given to the gas—this being due to the restoration of the hydrocarbons consumed to the air supply. Richer gas, giving a higher flame, has its air supply restricted, causing the tip of the flame to darken in color, and to elongate, instead of being strictly defined.

The next burner to claim brief notice was Bray's "Adjustable," by which the efficiency of that maker's ordinary burners has, it was stated, been increased 50 per cent. in some forms; in others, not quite so much.

The lecturer then turned his attention from the burners to the gas consumed. He defined flame as being matter undergoing chemical combination. Explaining this statement, he dealt, in an explicit manner and at some length, with the constituents of coal gas. This was followed by an examination of the physical behavior of the gas flame. Flat flames, he said, consist, generally speaking, of four parts: (1) An outer sheath or mantle surrounding the whole flame—visible when the luminous parts are hidden, or when a little sodium vapor is allowed to come in contact with the flame—due to the rapid and complete combustion of some of the gas; (2) an inner bright blue portion, visible at the base of the flame, due to the large quantity of air at that point; (3) the yellow and luminous part of the flame when the heat from the outer sheath and inner portion is decomposing the hydrocarbons, setting free the carbon, which glows and burns; and (4) a dark inner region of unburnt gas, surrounded with the products of combustion. Mr. Somerville proceeded to explain Professor Lewes's acetylene theory, and the members were, in this connection, particularly interested in the the flames produced by a sample of acetylene gas which the lecturer had provided. Having shown that the immediate formation of acetylene in flames reduces the inner bright blue portion, or, in other words, quickens the production of luminous flame, the lecturer remarked that it should therefore be produced as quickly as possible. This is to be done by increasing the temperature at the outlet of the burner; and this is what is performed by regenerative burners. This class of burner was then explained by means of one of Sugg's "Alladdin" lamps, the construction of which is very simple, but nevertheless, with a consumption of 3.76 cubic feet of gas, it affords, he believed, an illuminating power of nearly 25 candles.

Mr. Somerville passed on to the consideration of non-luminous flames, employing, as an example, a Bunsen burner. The great heat of these flames, and the absence of carbon particles, is made use of in incandescent burners. The burner used with the Welsbach light he described as a very clever one, because it comes so near the explosion point; and by it, in conjunction with the mantles, a light of from 50 to 60 candles, and even higher, can be obtained.

Concluding his lecture, Mr. Somerville observed that the first burner he showed was capable of giving a light of about 1 candle per cubic foot; and, passing along, this value rose to 2, 3, 8 and 15 candles per cubic foot, and, adding acetylene gas, an efficiency of nearly 50 candles is obtained. Therefore, in the 100 years of gas lighting, the value of the light has been increased fifty times.

The Radiating Power of Welsbach Mantle Material.

The *Gas World* remarks that in "Wiedemann's Annalen der Physik and Chemie," Vol. LVI,, pp. 433-450, there is an interesting paper, from the physical laboratory of the University of Berlin, by Mr. Charles St. John, on "The Radiating Power of Substances at High Temperature, with Special Reference to Welsbach Mantles." It has been taken for granted, since the experiments of Rossetti and Rogers, among others, that the temperature of a Bunsen flame does not exceed 1,300° C.. or about 2,370° F. But the difficulty was that this temperature would not account for the richness of the Welsbach flame in rays of higher refrangibility toward the violet. It, therefore, seemed necessary to assume that the Welsbach mantle was luminescent; that is, that it shone on its own account, transforming waves of 1-wave length into waves of a shorter length. But there are two considerations against this. In the first place, Mr. St. John has found, as the result of careful experiments, that there is no more than a trace of either fluorescence or phosphorescence or luminosity on exposure to the radiation from a cathode terminal of an induction coil; all of which goes to prove that there is none of this luminescence, and that the effect ought to depend on the temperature alone. And, in the second place, the recent experiments of Waggener and MacCrae show that, after all we ought not to speak of the comparatively cool flame of the Bunsen flame, for the temperature of the hottest part of that flame is not below 1,725° C. (3,140 F.), and may even be above the melting-point of platinum (1,775° C., or 3,230° F.)—a temperature which is quite sufficient to account for the kind of light produced, provided that the mantle attains that temperature.

Experiments to ascertain the radiating power of different oxides have hitherto been conducted on the following lines: A strip of platinum is coated with the oxide on one side; a current is passed through the platinum until it becomes white hot; the temperature attained by the platinum is calculated after measuring its expansion; the light emitted by the platinum and that emitted by the coating of oxide are respectively measured and compared; and this gives the light radiating power of the oxide as compared with that of the platinum. But in this it is assumed that the temperature of the oxide is really the same as that of the platinum which is coated with it; and it turns out that this cannot be the case. The oxide is cooler than the platinum, and gives out less light than it would do if it were actually brought to the same temperature as the metal. The results are, therefore, too low.

When, on the other hand, the coated platinum, or better, a strip of platinum only partly coated, is put inside a porcelain furnace, the whole comes up, both platinum and oxide, to the temperature of the furnace. On looking at it through a small hole in the side, the whole thing is at the same brightness as the background, the glowing walls of the furnace chamber. The light coming from it then consists of two parts or portions; some which it is itself radiating, and some which it is reflecting. The platinum acts as a better mirror though a worse radiator; the oxide acts a worse mirror but a better radiator; and when things have settled down into thermal equilibrium, these advantages and disadvantages exactly balance one another, so that all appears equally bright. But if we can cut off the mirror effect, we get the radiation alone; and this can be accomplished by running a cool tube through the peep-hole, close up to the hot partly coated platinum, so as to cut off any opportunity that object may have of reflecting light from the hot furnace walls to the eye. It is then seen that the bare platinum appears very dark in comparison with the oxide upon it. The presence of the tube will, of course, have a chilling effect; but it would chill the oxide more than the platinum, because the oxide is the better radiator; and hence the results will come out somewhat to the disparagement of the radiative power of the oxide. But even in spite of this, the radiative power of the oxide is found to be much greater than that found in the other mode of experiment.

The average result of many tables of experimental data is that, for light of an average wave-length, the two methods show:

	Platinum.	Magnesia.	Zirconia.	Erbia.	Lanthania.
Electric current method...	1.00	1.26	1.81	1.70	1.88
Furnace chamber method.	1.00	3.81	4.04	3.35	2.27

The curious thing in this is that erbia and lanthania should really have such low emissive powers as compared with magnesia; and it also shows that lanthania gives results the most nearly true by the earlier method, which is a consequence of its being the best conductor of heat.

Then Mr. St. John applied himself to find out why a Welsbach hood gradually loses lighting power as it is kept in use. He found that the material itself does not lose at all in two hours. Then he turned to the mantle. The mantle, when burned, is about half the size of the original cotton; and the question then was, Does the mantle not shrink still further when in use? He found that the strands do shrink; in 22 hours a diameter of 0.0071-inch becomes one of 0.0061; and this diminishes the heating surface, and the luminous surface, available for a given quantity of the incandescent oxide.

Finally, the principle of the Welsbach burner seems to be to heat to whiteness, in the hottest part of the Bunsen flame, a refractory material of very small mass, poor conductivity for heat, great surface, and high emissive power.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

At the annual meeting of the Belleville (Ont.) Gas Company, which plant is operated by Mr. W. H. Pearson, Jr., of Toronto, as lessee, the following officers were elected: Directors, John Bell, J. W. Johnson, James Brown, George Wallbridge, F. Dolan, J. E. Walmsley and J. L. Biggar; President, John Bell; Vice-President, J. W. Johnson; Secretary and Treasurer, J. L. Biggar.

Mr. N. W. Turner, who had for many years been Director of the Chelsea (Mass.) Gas Light Company, died at his home, Jamaica Plain,

Mass., on the morning of February 22d. Deceased, who was in his 85th year, was in the employ of the Boston Gas Company half a century ago, and at the time of his resignation from its service (1851) was foreman of the old Boston works. He engaged in the year named in the lamp and gas fixture business, his Company (the N. W. Turner Company, Bromfield street), being the pioneer in that line in Boston; and remained in the trade until 1888.

A CORRESPONDENT at Grand Forks, North Dakota, forwards the following: "The stockholders of the Grand Forks Gas and Electric Company in annual meeting elected the following Directors: W. J. Murphy, J. J. Dwyer, W. H. Higham, H. L. Whithed, D. W. Luke and Thos. Roycraft. The Directors named the following executive management: President, H. L. Whithed; Vice-President and General Manager, W. J. Murphy; Superintendent, Thomas Roycraft. The business of the year was up to the point of enabling the declaration of a substantial dividend."

THE Directors of the Norristown (Pa.) Gas Company have by means of a circular letter, advised the shareholders that they (the Directors) unanimously recommend the acceptance of an offer of $52 per share, made for all of the stock outstanding (about $150,000), by Mr. Jerome B. Gray, of West Chester, Pa.

SUPT. CAUGHLIN, of the Vicksburg (Miss.) Gas Light Company, has arranged for an important addition to the Company's main system. The pipe for the extensions has been received and the work of burying it will be commenced at once.

THE following respecting the operation of the gas works of Danville, Va., for the year 1895, is from the report of the City Engineer, Mr. C. A. Ballou:

"The accompanying statement shows in detail the running of the Gas Department. The receipts and disbursements, not properly belonging to the operations of the year, are eliminated, showing as near as practicable the net receipts and disbursements for the year. The following is a synopsis of the statement, viz.:

Receipts.

Received from and due by gas takers	$16,151.10	
" " " on coke, lime and tar acct.	2,044.45	
		$18,195.55

Disbursements.

For ordinary running expenses	$16,503.95	
" new mains laid	480.95	
		$16,984.90
Balance in favor of the department		$1,210.65
Or, more properly, by eliminating cost of new mains		480.95
The net revenue would be		$1,691.60

"Gas made during year, as per station meter, 21,902,800 cubic feet; loss by leakage and condensation, 2,851,500 cubic feet; amount consumed by gas takers, to 15th December, 16,816,100 cubic feet; consumed in public buildings, 1,035,200 cubic feet; estimated consumption, last 15 days in December, 1,200,000 cubic feet. During the year the time for reading meters was changed and made 15 days earlier in the month, so that the last 15 days of December would not be embraced in the year's consumption, as shown by meters. In order to make a proper comparison, I have made a moderate estimate of the probable consumption in this time, as shown above. The coal carbonized during the year was 4,796,400 pounds. The average yield was 4.56 cubic feet per pound and the candle power average was 16.23. We used Kanawha coals altogether, which were furnished under a 12-months' contract. The coal came from a variety of mines, some of which did not give satisfactory results, and the average yield is not as high as we hoped it would be. I would advise that in the future coal from some definite mines be specified in the coal contracts. There has been no interruption in our furnishing the greatest abundance of gas for all demands during the whole year. So far as I know, the character of the light has given the greatest satisfaction; notwithstanding, it would be gratifying to use some enricher, so as to increase the candle power. We have made an earnest effort to reduce the amount of unaccounted for gas, and thus far the results of our efforts have been encouraging. In the year 1893 the loss was 18 per cent.; in 1894, 16.3 per cent., and during the past year, 13.02 per cent. In the lines of the old mains we found some broken pipe, a large number of leaky joints, and replaced a number of defective service pipes with new galvanized pipe. We hope to be able to reduce this percentage of loss. The increase in the output of gas during the past year, over that of 1894, was 7.8 per cent., which is reasonably encouraging, taking into account the stringency of the times. In 1887 a considerable amount was expended in improving the works, affording better facilities for supplying the increasing demand for gas, and producing it at less cost and of better quality. During this time (8 years) the price has been reduced from $2 to $1, and the consumption has increased 124 per cent. This increase has been far more than was anticipated and necessitates more frequent renewals of our benches than was predicted. Two benches were renewed during the year and two more will require renewal this year. We purchased new covers for the purifiers, made some improvements in the retort house and repaired the coal sheds." Engineer Ballou then goes on to enumerate the length and diameter of the pipe extensions for the year, and concludes by stating that the gas takers now number 670.

ENGINEER BALLOU also details the operations of the city electric lighting plant, which does not seem to have been quite as profitable as the gas plant. He says: "The accompanying statement shows the receipts and disbursements in the electric light department for the year, a summary of which is as follows:

Total disbursements	$4,747.42
Total receipts	1,015.15
Showing a deficit of	$3,732.27
In the item of disbursements is embraced the cost of a new 50-light arc dynamo, 10 arc lamps, 1 mile line wire, freight, drayage and cost of new circuit, amounting to	1,400.00
Making net cost of street lighting	$2,332.27

"During the year a 50-light arc dynamo was purchased, together with 10 arc lamps, 12 series lamps, one mile of line wire and another circuit arranged. The Neapolis machine was taken out to make room for this new machine. The armature of one of the old machines was burnt out. A new armature was purchased and the old one rewound and kept for use in case of accident. Before the purchase of the new machine the most of the lamps which were used for commercial purposes were taken for use on the streets. We have now an abundance of capacity for furnishing commercial lights, and the price having been reduced we have hopes that they will be liberally used. We have now 91 arc lights for street lighting. The benefits derived by the city from its light department in furnishing gas for lighting public buildings and electric lights for the streets are shown in the following statement. In this statement the amount of gas used is taken from meters at each building and calculated at $1 per 1,000 cubic feet and the street lamps calculated at the same price at which they are rented:

Gas consumed at court room and offices	$61.00
" " " corporation jail	107.00
" " " hook and ladder house	47.20
" " " fire engine house	105.40
" " " gas house	366.70
" " " council chamber, offices city hall	227.40
" " " Union street bridge	120.50
85 arc lamps on streets	8,500.00
Net revenue from gas department	1,691.60
Total	$11,226.80
Less deficit in running electric light works	2,332.27
Showing total value of service	$8,894.53

THE Berlin Iron Bridge Company, of East Berlin, Conn., has just completed, for the Citizens Gas Company, Bridgeport, Conn., two large buildings, one structure, which is 63 feet wide by 171 feet in length, is intended to serve as a purifier house, with meter house and valve house, all in separate rooms; the second building, which is 44 feet wide by 122 feet long, will house the generating and scrubbing apparatus, and the operating engines and steam raising apparatus as well. The side walls are of brick and the roof trusses are of steel, covered with corrugated iron.

DEEDS recently filed with the County Clerk, of Erie county, N. Y., go to show that the Buffalo (N. Y.) Gas Light Company has acquired the irregularly shaped plot of land, lying between Forest avenue, Niagara street and the canal and river, formerly known as the Pratt Rolling Mill plot. The conveyance was made by Mr. Pascal P. Pratt, and the consideration named in the deed is a nominal one. The plot covers about 4½ acres and its acquisition by the Company looks to us to foreshadow the erection by it of a manufacturing plant in the Black Rock district; although we have only guesswork to offer as the basis

of such foreshadowing. The proceeding also goes to show how much Mr. Spaulding and his associates fear the bombastic shouting of the manipulators of the Queen City gas charter.

THE proprietors of the Benicia (Cal.) Gas Company have sold out their property and franchises to the local Solano Electric Light Company, and the gas works will be shut down.

MR. GEORGE MCLEAN, Secretary of the Key City Gas Company, of Dubuque, Iowa, writing under date of Feb. 26th, says: "The Key City Gas Company has reduced rates to $1.50 per 1,000 cubic feet for illuminating purposes, and $1.25 for fuel use; the reduction to take effect April 1, 1896. The Company will at once rebuild its works. A modern retort house will be constructed, of 240,000 cubic feet daily capacity, and a water gas plant of 225,000 cubic feet will be installed. New 16-ft. purifying boxes and purifying apparatus up to date will be installed in a modern purifying house, and a new station meter will also form part of the new equipment."

MR. J. R. TODD seems to have been the right sort of a man to assume charge of the works end of the Dedham and Hyde Park (Mass.) Gas Light Company, for since taking hold there (August 1, 1894), the increase in the number of consumers' meters is just 116. The increase in the sendout for 1895, as compared with 1894, amounted to 25 per cent., and the increase for January, 1896, against January, 1895, was 35 per cent. Since his advent there, Mr. Todd has set up 58 gas cookers of different styles and kinds, and 28 heating stoves also were placed. The veteran says that the coming season will be a busy one for him in the gas cooking line, judging by the advance orders in hand for such apparatus, the orderers thereof being anxious to have the service pipes placed as soon as the frost is out of the ground. So it appears that Mr. Todd has cause to be satisfied with himself, and that the Company should be satisfied with him.

THE Providence (R. I.) *Bulletin*, of Feb. 29th, conveys this rather puzzling information—puzzling in that the proprietors of the Pawtucket Gas Light Company always claimed to have made money out of the electric annex: "Within the past few days the Pawtucket Gas Company and the Bridge Mill Power Company have sold all their electrical interests to a new Company, to be known as the Pawtucket Electric Company. This is the result of negotiations which have been pending for some time between these two Companies, rumors of which have reached the public now and then, but which could not be confirmed. The rumors were to the effect that these two Companies were to consolidate, but this is not the case. The Pawtucket Gas Company will continue to do business in the manufacture and supply of gas as heretofore, and the Bridge Mill Power Company will continue to improve its property and to utilize the immense amount of water power in its control. The Pawtucket Gas Company was owner of the Pawtucket Electric Lighting Company, and the latter property is the one that was sold. It has been generally understood that the Pawtucket Gas Company and the Pawtucket Electric Lighting Company were one corporation, but this was not so. The last named Company was owned by the Company first named. This agreement, for it can hardly be called either a combination or a consolidation, though it partakes somewhat of the nature of these, puts an end to the fight between the two Companies, which has been carried on for a long time and which has been a severe one."

MR. A. F. NASH, President of the Windsor (Ont.) Gas Company, informs us that all the properties of the Company have been sold to people interested in the Ontario Natural Gas Company. Dr. S. A. King, Managing Director of the last named concern, is largely interested in the purchase noted, and we understand that the adjoining town of Walkerville is to be connected with the Windsor Company's pipe system.

THE gas plant at Elmira, N. Y., is to be remodelled, and a reduction in the selling rate is also promised.

THE proprietors of the Bordentown (N. J.) Gas Light Company propose to install a water gas plant, to extend the main system, to lower the selling rate, and, generally, to adopt commonsense methods of conducting their business.

THE New Britain (Conn.) Company will extend its main system this season.

THE plant at Princeton, N. J., is also to be overhauled.

ACCORDING to the eleventh annual report of the Massachusetts Board of Gas and Electric Light Commissioners, there are now under the supervision of the Board lighting plants owned by 131 corporations and 12 towns. Of the former, 47 are engaged in the supply of gas only, 24 supply both gas and electric light, and 60 supply only electric light. Of the towns, two have plants for the supply of both gas and electric light, the others supply only electric light. The recommendations of a year ago are repeated, namely, that the Board should have like authority with respect to manufacturing records as it already has in regard to uniformity in accounts; that the provisions of chapter 450 of the Acts of 1894 authorizing the Board to apply to the courts for the enforcement of its legal orders be extended to orders made by the Board, and that the report of the State Inspector of Gas and Gas Meters should be combined with the report of the Commissioners. Official reports relative to action about a municipal plant for gas or electric lighting have been received from 238 towns and cities. Included in this number are all those in which the population exceeds 1,500. Of these municipalities, 212 have taken no action during the year 1895. The cities of Quincy, Taunton and Waltham and the town of West Springfield have considered the subject for the first time. The new plants in Marblehead and Reading have been put in operation during the year. The following named towns have now plants in operation: Braintree, Danvers, Hingham, Hull, Marblehead, Middleboro, Needham, North Attleboro, Peabody, Reading, Wakefield and Wellesley. Of these, Middleboro and Wakefield only have plants to supply both gas and electric lights. The others supply only electric lights. The towns of Danvers, Needham and Wellesley have plants for street lighting only; the last two purchase their electricity for this purpose from the Natick Gas and Electric Company, and have recently concluded 5-years' contracts with this Company, under which it is to have the exclusive right to supply commercial lights directly to residents of both towns. The town of Hingham also buys its electricity from a private Company. The total receipts of all the Gas Companies were $5,280,887.86, against $5,042,868.86 in 1894. The expenses were $3,770,751.18; in 1894, $3,633,354.91. This leaves an apparent net profit of $1,510,136.68 in 1895, and of $1,409,513.95 in 1894. Adding interests, rents and profits from electric lighting, we have total profits of $1,776,985.67 in 1895 and $1,757,061.03 in 1894. Deducting payments on bonds and loans, dividends, etc. ($2,063,935.48 and $1,805,497.43), there is a deficit of $286,949.81 in 1895, against $108,436.40 in 1894. Two of the Companies appear not to have earned expenses, and 22 others have not earned sufficient to warrant the declaration of any dividend. The receipts from gas sold by meter show an increase of $279,216.11. In the year 1894 a decrease was shown from the previous year of $938,697.32, and this was attributed to the large reduction in price by the Boston Companies and to the general financial depression. The increase given for 1895 is the largest of any year since the returns have been made, and is due to an unusual percentage of increase in the output of most of the Companies. Receipts from public lamps have this year decreased $23,853.35. As in the previous year, nearly all of this has been borne by the Companies supplying the street lights in Boston. The charges for depreciation have been unusually large, and it is due to this fact that the entire operations of the year again show a deficit. The value of the gas plants assessed by the local assessors is then, in round numbers, $16,900,000. The total sum paid by the Companies for taxes, including State inspection, after apportioning to electric account that part of the Gas Companies' taxes belonging to their electrical departments, was $271,810.71, an average of 6 cents per 1,000 feet of gas sold, being a decrease from the previous year in the total amount of $2,335.33, and a decrease of seven-tenths of a cent for every 1,000 feet sold. The average price paid by consumers for coal gas to the Companies selling annually more than 30,000,000 feet each is $1.03 per 1,000 feet. If the Boston and Bay State Companies be excluded the average is $1.23. The average price received by the remainder of the Coal Gas Companies from sales by meter is $1.74, making an average for all of $1.10 per 1,000. The average price for oil gas is $3.90 per 1,000 feet. The average price paid for coal gas in 1886 was $1.72; in 1887, $1.66; in 1888, $1.56; in 1889, $1.45; in 1890, $1.39; in 1891, $1.31; in 1892, $1.38; in 1893, $1.27, and in 1894, $1.26. Six of the Electric Lighting Companies appear not to have earned expenses, and 33 others have not earned sufficient to warrant the declaration of any dividend. The gross profits of the Companies doing only an electric business have increased over the previous year by $137,763.41, and although interest and dividend charges have decreased, the increased depreciation and miscellaneous charges show a deficit for the year instead of a surplus as in 1894.

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MONDAY, MARCH 9, 1896.

The Market for Gas Securities.

The market for city gas shares is in the betwixt-and-between stage, the prevailing feature being a sullen strength that will not be goaded to weakness nor coaxed towards buoyancy. Consolidated opened to day (Friday) at 155½ bid, and was offered at a point higher. This, of course, is ex-dividend of 2 per cent., the regular for the quarter ended February last. Standard common is in good request, at 78 to 81, and the preferred holds about as it did a week ago—108 to 110. Equitable shows no change of moment; neither does Mutual, although the bid rate is returned at 225, a decline of 5 points from our last figure. New York and East River issues are fairly well maintained. There has been no change of moment in the situation at Albany, where cool reasoning appears to be governing the committees having the rate bills in charge. The Solons seem to recognize the fact now that the gas sold in New York City (which is, as has been often said in these columns, the best gas made and sold in the world) is cheap at $1.25 per 1,000, even from the consumers' point of view. Meanwhile our friends, the electricians, are having scrutiny made by the Legislature of their selling rates. They will soon know how it is themselves. The high figures made in Brooklyn Union a fortnight or so ago are well maintained. Some folks say that this stock ought to go par on the showing of earning powers made. The Baltimore situation is a trifle mixed; but we think it is safe to predict that the Legislature will leave things there as they are. The stock is 58½ bid. Chicago is a trifle weaker, speculators evidently preferring to wait for the decision on the writ to oblige the Secretary of State to issue a charter. It doesn't matter much whether the writ issues or not; if Illinois won't do it, New York will likely see that justice is done in the matter of the rehabilitation of Chicago's gas interests. The stock is a purchase at the market. Laclede is again on the rise, and Western gas looks a purchase. Even Bay State took on strength, selling above 20.

Gas Stocks.

Quotations by Cochran & Close, Brokers and Dealers in Gas Stocks.

35 WALL ST., NEW YORK CITY.

MARCH 3.

☞ All communications will receive particular attention.
☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$35,430,000	100	155½	156½
Central	500,000	50	150	..
" Scrip	220,000	..	100	.
Equitable	4,000,000	100	211	213
Bonds, 6's	1,000,000	1,000	105	..
" 1st Con. 5's	2,300,000	1,000	114	.
Metropolitan Bonds	658,000	..	108	112
Mutual	3,500,000	100	225	..
" Bonds	1,500,000	1,000	100	102
Municipal Bonds	750,000	.	..	.
Northern	150,000	50	79	80½
" Bonds	150,000	1,000	..	98
New York and East River	5,000,000	100	37	39
Preferred	2,000,000	100	72	75
Bonds 1st 5's	3,500,000	1,000	100	101½
" 1st Con. 5's	1,500,000	..	88	89
Richmond Co., S. I.	348,650	50	50	..
" Bonds	100,000	1,000	..	..
Standard	5,000,000	100	78	81
Preferred	5,000,000	100	108	110
Bonds, 1st Mortgage, 5's	1,500,000	1,000	108	110
Yonkers	299,650	50	112	.
Out-of-Town Companies.				
Brooklyn-Union	15,000,000	100	86	..
" " Bonds (5's)	15,000,000	1,000	105¾	106½
Bay State	5,000,000	50	20½	20¾
" Income Bonds	2,000,000	1,000	..	80
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	..	80
2d " " "	3,000,000	1,000	51½	53½
Buffalo Mutual	750,000	100	125	..
" Bonds	200,000	1,000	95	100
Central, San Francisco	2,000,000	..	95	..
Chicago Gas Co.	25,000,000	100	66¾	66½
Chicago Gas Lt. & Coke Co. Guaranteed Gold Bonds.	7,650,000	1,000	94	94¼
Columbus	1,000,000	..	66¾	67
1st Mortgage	1,085,000	..	94	95
Consumers, Jersey City	2,000,000	100	77	..
" Bonds	600,000	1,000	102	105
Cincinnati G. & C. Co.	7,000,000	100	208	..
Consumers, Toronto	1,800,000	50	184½	187
Capital, Sacramento	500,000	50	..	41
Bonds (6's)	150,000	..	..	..
Consolidated, Baltimore	1,000,000	100	58½	60
Mortgage, 6's	3,500,000	..	107	107½
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490,000	..	..	..
Detroit	4,000,000	..	..	29
" Con. Bonds	4,312,000	..	71½	75
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Fort Wayne	2,000,000	..	76½	79
" Bonds	2,000,000	..	90	93
Hartford	750,000	25	..	145
Indianapolis	2,000,000	..	139	143
" Bonds, 6's	2,650,000	..	105	107
Jersey City	750,000	20	180	..
Lafayette Gas Co., Ind.	1,000,000	100	85	90
Bonds	1,000,000	1,000	91	94
Louisville	2,370,000	50	..	130
Laclede, St. Louis	7,500,000	100	27¼	27½
Preferred	2,500,000	100	80	81
Bonds	9,084,400	1,000	94½	95
Little Falls, N. Y.	50,000	100	..	100
Bonds	25,000	..	..	100
Montreal, Canada	2,000,000	100	200	.
Newark, N. J., Gas Co.	1,000,000	..	93	98
Bonds, 6's	4,000,000	.	123	..
New Haven	1,000,000	25	225	..
Oakland, Cal.	2,000,000	..	46½	..
" Bonds	750,000	..	..	..
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	2,100,000	1,000	..	108
2d "	2,500,000	1,000	104	105
Peoples, Jersey City	500,000	50	..	175
Paterson, N. J.	.....	25	99	102
Rochester Gas & Elec. Co.	2,150,000	50	..	..
Preferred	2,150,000	50	88	..
Consolidated 5's	2,000,000	..	87½	90
San Francisco, Cal.	10,000,000	100	71½	72
St. Paul Gas Light Co.	1,500,000	100	68½	70
1st Mortgage, 6's	650,000	..	88	90
Extension, 6's	600,000	..	..	..
General Mortgage, 5's	2,400,000	..	88	90
Syracuse, N. Y.	500,000	25	..	..
Washington, D. C.	2,000,000	20	250	..
Western, Milwaukee	4,000,000	100	65	68
Bonds, 5's	3,556,000	..	83½	91
Wilmington, Del.	500,000	50	188	190

Advertisers' Index.

GAS ENGINEERS.

	Page
Jos. R. Thomas, New York City	401
Wm. Henry White, New York City	399
Fred. Bredel, Milwaukee, Wis.	395
H. C. Slaney, Brooklyn, N. Y.	399
Geo. R. Rowland, New York City	399
The Western Gas Construction Co., Fort Wayne, Ind.	390
Humphreys & Glasgow, New York City	386
T. G. Lansden, St. Louis, Mo.	399
American Gas Co., Phila., Pa.	383

CHEMISTS.

Herman Poole, New York City	382

PROCESSES.

Bartlett, Hayward & Co., Baltimore, Md.	397
United Gas Improvement Co., Phila., Pa.	389
Burdett Loomis, Hartford, Conn.	398
National Gas and Water Co., Chicago, Ills.	391
Economical Gas Apparatus Construct'n Co., Toronto, Ont.	397
The Western Gas Construction Co., Fort Wayne, Ind.	390

GAS WORKS APPARATUS AND CONSTRUCTION.

James R. Floyd & Sons, New York City	400
Continental Iron Works, Brooklyn, N. Y.	398
Deily & Fowler, Phila., Pa.	400
Kerr Murray Mfg. Co., Fort Wayne, Ind.	396
Stacey Mfg. Co., Cincinnati, Ohio	399
Bartlett, Hayward & Co., Baltimore, Md.	397
Davis and Farnum Mfg. Co., Waltham, Mass.	396
R. D. Wood & Co., Phila., Pa.	398
Isbell-Porter Company, New York City	398
Fred. Bredel, Milwaukee, Wis.	395
United Gas Improvement Co., Phila., Pa.	389
Berlin Iron Bridge Co., East Berlin, Conn.	386
National Gas and Water Co., Chicago, Ills.	391
Economical Gas Apparatus Construct'n Co., Toronto, Ont.	397
The Western Gas Construction Co., Fort Wayne, Ind.	390
Humphreys & Glasgow, New York City	386
Gas Engineering Co., Pittsburgh, Pa.	396
American Gas Co., Phila., Pa.	383

SCRUBBERS AND CONDENSERS.

G. Shepard Page's Sons, New York City	399
R. D. Wood & Co., Phila., Pa.	393
James R. Floyd & Sons, New York City	400
Continental Iron Works, Brooklyn, N. Y.	398
Gas Engineering Co., Pittsburgh, Pa.	396

REGENERATIVE FURNACES.

Bartlett, Hayward & Co., Baltimore, Md.	397
Fred. Bredel, Milwaukee, Wis.	395
J. H. Gautier & Co., Jersey City, N. J.	395
Parker-Russell Mining and Mfg. Co., St. Louis, Mo.	391
Adam Weber, New York City	391

TAR AND CARBONIC ACID EXTRACTOR.

G. Shepard Page's Sons, New York City	399

AMMONIA CONCENTRATORS.

Michigan Ammonia Works, Detroit, Mich.	380
G. Shepard Page's Sons, New York City	399
Gas Engineering Co., Pittsburgh, Pa.	393

GAS METERS.

John J. Griffin & Co., Phila., Pa.	404
American Meter Co., New York and Philadelphia	403
The Goodwin Meter Co., Phila., Pa.	402
Helme & McIlhenny, Phila., Pa.	403
D. McDonald & Co., Albany, N. Y.	413
Nathaniel Tufts, Boston, Mass.	402
Maryland Meter and Mfg. Co. Baltimore, Md.	402
Metric Metal Co., Erie, Pa.	401
Keystone Meter Co., Royersford, Pa.	402
The Hillen Meter Co., Brooklyn, N. Y.	403

PREPAYMENT METERS.

American Meter Co., New York and Philadelphia	403
John J. Griffin & Co., Phila., Pa.	404
D. McDonald & Co., Albany, N. Y.	403

GAS AND WATER PIPES.

Ohio Pipe Co., Columbus, Ohio	401
M. J. Drummond, New York City	401
R. D. Wood & Co., Phila., Pa.	393
Warren Foundry and Machine Co., New York City	401
Donaldson Iron Co., Emaus, Pa.	401
Addyston Pipe and Steel Co., Cincinnati, O.	401

GAS BAGS.

Peerless Rubber Mfg. Co., New York City 381

STEAM BLOWER FOR BURNING BREEZE.

H. E. Parson, New York City 395

GAS COALS.

Penn Gas Coal Co., Phila., Pa 398
Perkins & Co., New York City 392
Despard Gas Coal Co., Baltimore, Md 398
Westmoreland Coal Co., Phila., Pa 393
Berwind-White Coal Mining Co., New York and Phila ... 392
Henry C. Scheel, New York City 393

CANNEL COALS.

Perkins & Co., New York City 392
Henry C. Scheel, New York City 393

GAS ENRICHERS.

Standard Oil Co., New York City 398
The Sun Oil Co., Pittsburgh, Pa 393
W. H. Townsend, New York City 398

COKE CRUSHER.

C. M. Keller, Columbus, Ind 398

CONVEYING MACHINERY.

C. W. Hunt Company, N. Y. City 382

GAS GAUGES.

The Bristol Co., Waterbury, Conn 382

GAS GOVERNORS.

Connelly Iron Sponge and Governor Co., New York City. 391
Isbell-Porter Co., New York City 398
The Wilder Mfg. Co., Phila., Pa 380

SELF-SEALING MOUTHPIECE DOORS.

Isbell-Porter Company, New York City 398
Continental Iron Works, Brooklyn, N. Y. 398
G. Shepard Page's Sons, New York City 399

RETORTS AND FIREBRICK.

J. H. Gautier & Co., Jersey City, N. J 394
B. Kreischer & Sons, New York City 394
Adam Weber, New York City 394
Laclede Firebrick Mfg. Co., St. Louis, Mo 394
Cyrus Borgner, Phila., Pa 394
James Gardner, Jr., Pittsburgh, Pa 394
Henry Maurer & Son, New York City 394
Baltimore Retort and Firebrick Co., Baltimore, Md 394
Parker-Russell Mining and Mfg. Co., St. Louis, Mo 394
Brooklyn Firebrick Works, Brooklyn, N. Y. 394

CEMENTS.

C. L. Gerould & Co., Mount Vernon, N. Y. 394

INCANDESCENT GAS LAMPS.

Welsbach Commercial Co., Phila., Pa 383

MICA GOODS.

The Mica Mfg. Co., New York City 380

BURNERS.

C. A. Gefrorer, Phila., Pa 398
George Bray & Co., Leeds, England 385

LAVA GAS TIPS.

D. M. Steward Mfg. Co., Chattanooga, Tenn 380

GAS TUBING.

New York Gas Tubing Co., New York City 382
J. C. Granger, New York City 382
Wm. M. Crane & Co., New York City 382

PURIFYING MATERIALS.

Connelly Iron Sponge and Governor Co., New York City 391
Greenpoint Chemical Works, Brooklyn, N. Y. 391
Henry W. Douglas, Ann Arbor, Mich 391

EXHAUSTERS.

The P. H. & F. M. Roots Co., Connersville, Ind 388
Isbell-Porter Company, New York City 398
Connelly Iron Sponge and Governor Co., New York City 391

VALVES.

Ludlow Valve Manufacturing Co., Troy, N. Y. 390
Chapman Valve Manufacturing Co., Boston, Mass 390
R. D. Wood & Co., Phila., Pa 398
Continental Iron Works, Brooklyn, N. Y. 398
The P. H. & F. M. Roots Co., Connersville, Ind 388
Isbell-Porter Co., New York City 398
The Western Gas Construction Co., Fort Wayne, Ind 390

ELECTRICAL APPARATUS.

Wm. Henry White, New York City 399

GAS ENGINES.

Otto Gas Engine Works, Phila., Pa 364
The American Gas Engine Co., Phila., Pa 384
Backus Water Motor Co., Newark, N. J 340

ENGINES AND BOILERS.

The Hazelton Boiler Company, New York City 381
W. G. & G. Greenfield, East Newark, N. J 381

PURIFIER SCREENS.

John Cabot, New York City 395

GAS STOVES.

American Meter Co., New York and Philadelphia 387
The Goodwin Meter Co., Phila., Pa 402
George M. Clark & Co., Chicago, Ills 385
Maryland Meter and Manufacturing Co., Baltimore, Md.. 402
William M. Crane & Co., New York City 382
Keystone Meter Co., Royersford, Pa 402
A. Weiskittel & Son, Baltimore, Md 381

CHINA GAS KILNS.

William M. Crane & Co., New York City 382

GASHOLDER PAINT.

New York Marine Paint Co., Poughkeepsie, N. Y. 390

RED CEDAR TANKS.

Williams Mfg. Co., Kalamazoo, Mich 341

GASHOLDER TANKS.

J. P. Whittier, Brooklyn, N. Y. 390

GASHOLDERS.

Bartlett, Hayward & Co., Baltimore, Md 397
Continental Iron Works, Brooklyn, N. Y. 398
Delly & Fowler, Philadelphia, Pa 400
Davis & Farnum Mfg. Co., Waltham, Mass 396
Kerr Murray Mfg. Co., Fort Wayne, Ind 396
Stacey Mfg. Co., Cincinnati, Ohio 399
R. D. Wood & Co., Philadelphia, Pa 398

PATENTS.

H. B. Willson & Co., Washington, D. C. 382

DIVIDEND NOTICE.

OFFICE OF WELSBACH COMMERCIAL COMPANY,
40 WALL ST., NEW YORK CITY, Feb. 13, 1896.

The Directors have this day declared a quarterly dividend of two (2) per cent on the preferred stock, payable on March 10, 1896, to stockholders of record at the close of business Feb. 29, 1896. Transfer books of the preferred stock will be closed from March 2 to March 10, both inclusive. Checks will be mailed.

1081-3 EDWARD C. LEE, Treasurer.

WANTED,

By a young man of 20 years' experience, a position to take full charge of a medium or small sized gas works; coal gas works preferred. A worker in all branches of the business—manufacturing, construction, mechanical and clerical; 7 years' experience in pushing the gas stove business. Would like a works where plant and business need building up. Can furnish competent and thoroughly reliable references.

080-4 Address "P. V. T.," care this Journal.

WANTED,

Two Purifying Boxes, 10x8x3 ft., or 10x12x3 ft.

Also, a **Tar Extractor,** 6-inch connections.

Address, with particulars and prices,

1082-2 "A.," care this Journal.

Wanted, Immediately,

Several Thoroughly Competent Meter Repairers.

Address, stating experience, references and wages expected,

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The Output of Bear Creek Cannel Coal—

the only high grade Gas Cannel available in large quantity—has been increased. We are anxious to add to our long list of Gas Companies using Bear Creek Cannel, and will be glad to furnish details as to cost and yield.

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Ammonia Concentrator.

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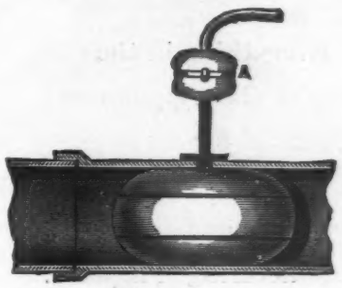

These Gas Bags are used to stop the flow of gas while repairing or making alterations in gas mains. There have been numerous cases of workmen being badly injured, and sometimes fatally, by the escape of gas resulting from the bursting of a bag, and our patent improvement is designed to obviate such calamities. The indicator *A* shows unerringly when the bag has been sufficienty inflated to pack the main, and when the pumping should be stopped. Our Bags are made of a rubber stock especially prepared to admit of great distension, and to resist the action of Oils, Gases, Naphtha and other residuum in the mains, and they are made with lapped joints, which adds greatly to their strength.

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5 " " "	1.05		20 " " "	12.00
6 " " "	1.75		24 " " "	17.00
8 " " "	2.65		30 " " "	27.50
10 " " "	3.75			

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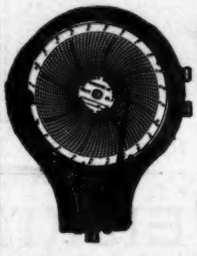

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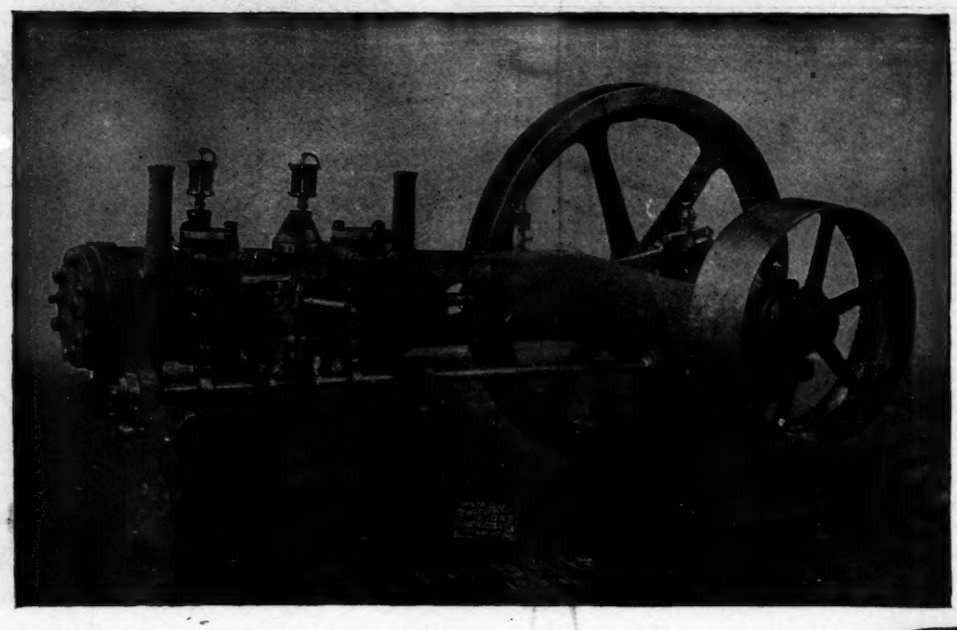

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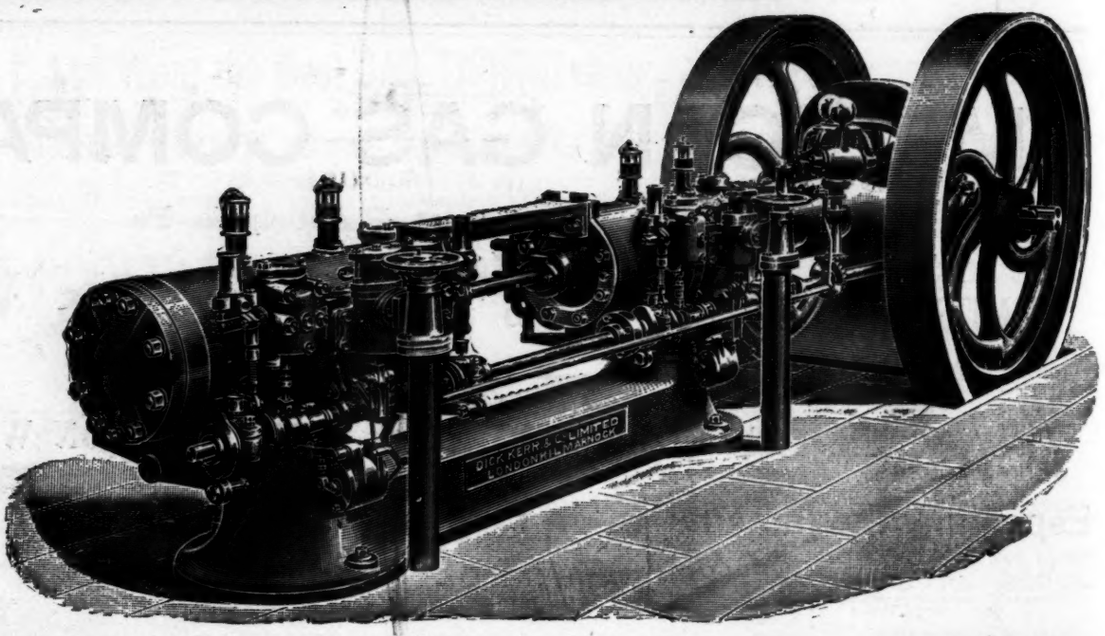

ESSENTIAL PRINCIPLE.—An impulse at each end of piston; using half force to each impulse; doubling the steadiness; reducing the wear on moving parts, and weight for given power. **CONSTRUCTION.**—The piston rod works through stuffing box in front end of cylinder, and connecting rod is carried in a cross-head working in a slide in frame, as in ordinary steam engine practice. All valves are of the poppet type, operated by cams on a single cam-shaft, giving positive movement to every working part. Tube or electric ignition. **RESULT.**—An engine of extreme simplicity and steadiness of action, the even wear on the cylinder and all working parts assuring increased economy, long life, and minimum cost in repairs. **RECORD.**—Successful and constant use in Great Britain for the past eight years. Address

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Slit Union.

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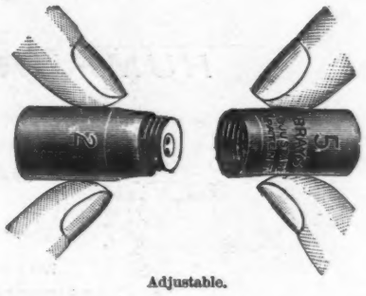
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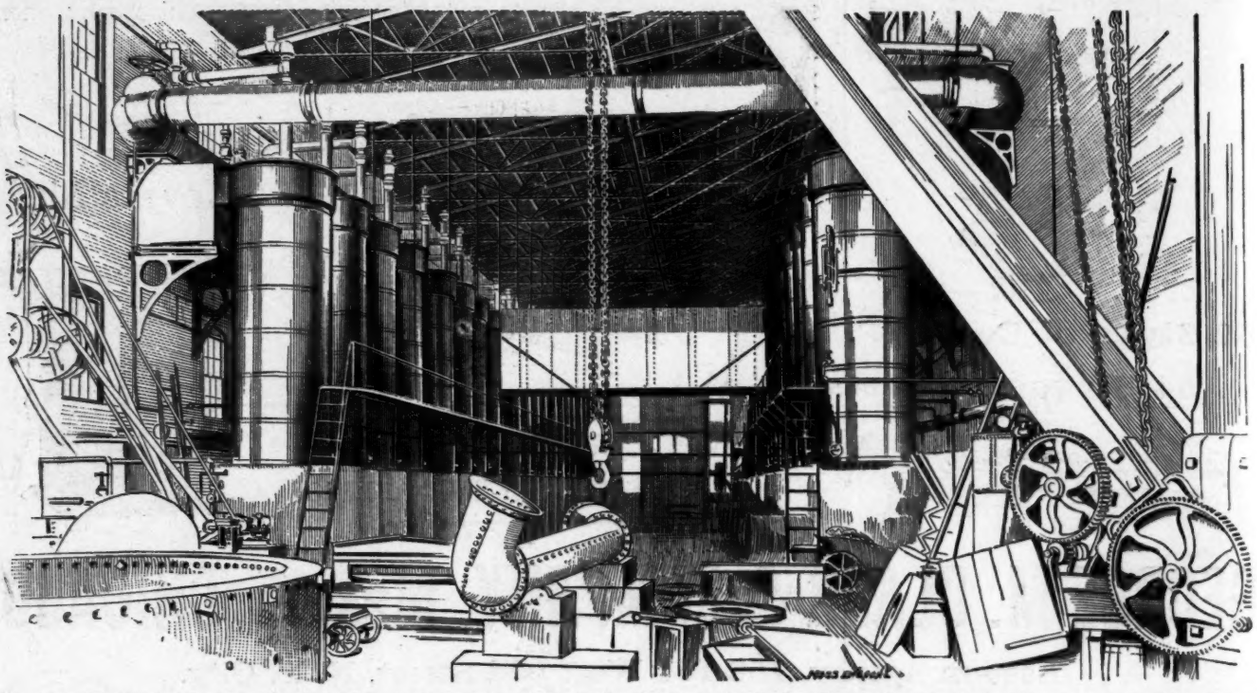

The above illustration is taken direct from a photograph, and shows the interior of a Boiler House, the Roof of which was designed and built by us for the Amoskeag Manufacturing Company, at Manchester, N. H. The building is 75 feet in width by 275 feet in length, the walls being made of brick and the roof being made of iron—iron trusses, iron purlins, and covered with corrugated iron—so that there is absolutely no woodwork anywhere about the building which can take fire. For Boiler Rooms this construction particularly commends itself.

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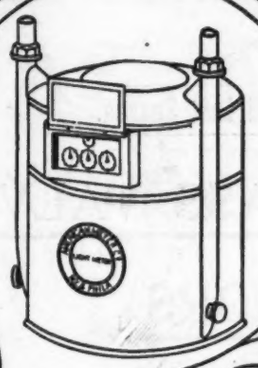

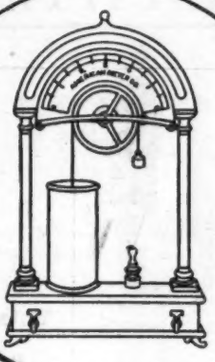

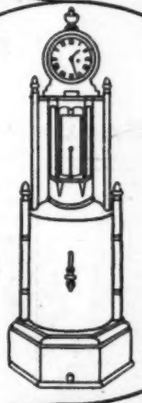

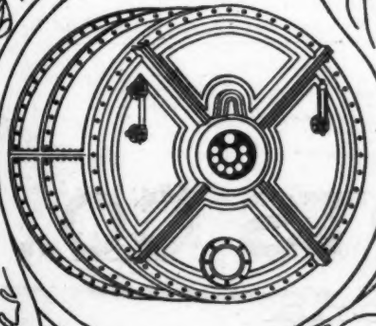

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SAN FRANCISCO.

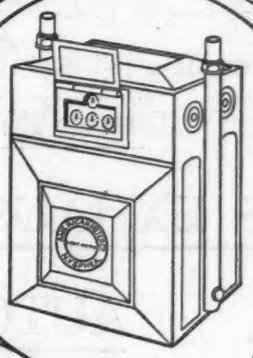
PUBLIC LIGHTING TABLE.

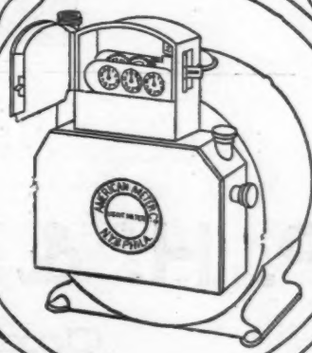
MARCH, 1896.

Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Table No. 1. Following the Moon. Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Table No. 2. New York City. All Night Lighting. Extinguish.
				P.M.	A.M.
Sun.	1	6.30 PM	9.30 PM	5.30	5.45
Mon.	2	6.30	10.50	5.30	5.45
Tue.	3	6.30	12.10 AM	5.30	5.45
Wed.	4	6.30	1.20	5.30	5.45
Thu.	5	6.30 LQ	2.30	5.40	5.35
Fri.	6	6.30	3.30	5.40	5.35
Sat.	7	6.30	4.20	5.40	5.35
Sun.	8	6.30	5.10	5.40	5.35
Mon.	9	6.30	5.10	5.40	5.35
Tue.	10	6.30	5.10	5.40	5.35
Wed.	11	6.30	5.10	5.40	5.35
Thu.	12	6.30	5.10	5.50	5.20
Fri.	13	6.30 NM	5.10	5.50	5.20
Sat.	14	6.30	5.10	5.50	5.20
Sun.	15	6.40	5.00	5.50	5.20
Mon.	16	6.40	5.00	5.50	5.20
Tue.	17	6.40	5.00	5.50	5.20
Wed.	18	9.40	5.00	5.50	5.20
Thu.	19	10.40	5.00	6.00	5.10
Fri.	20	11.40	5.00	6.00	5.10
Sat.	21	12.40 AM FQ	5.00	6.00	5.10
Sun.	22	1.30	4.50	6.00	5.10
Mon.	23	2.20	4.50	6.00	5.10
Tue.	24	2.50	4.50	6.00	5.10
Wed.	25	3.20	4.50	6.00	5.10
Thu.	26	3.50	4.50	6.10	4.55
Fri.	27	No L.	No L.	6.10	4.55
Sat.	28	No L. FM	No L.	6.10	4.55
Sun.	29	No L.	No L.	6.10	4.55
Mon.	30	6.50 PM	9.40 PM	6.10	4.55
Tue.	31	6.50	11.00	6.10	4.55

TOTAL HOURS LIGHTING DURING 1896.

By Table No. 1.	Hrs.Min.	By Table No. 2.	Hrs.Min.
January	220.40	January	423.20
February	207.00	February	367.40
March	193.00	March	355.35
April	174.10	April	298.50
May	164.00	May	264.50
June	142.10	June	234.25
July	142.10	July	243.45
August	150.50	August	280.25
September	163.00	September	321.15
October	193.10	October	374.30
November	207.00	November	401.40
December	237.30	December	433.45
Total, yr.	2194.40	Total, yr.	4000.00





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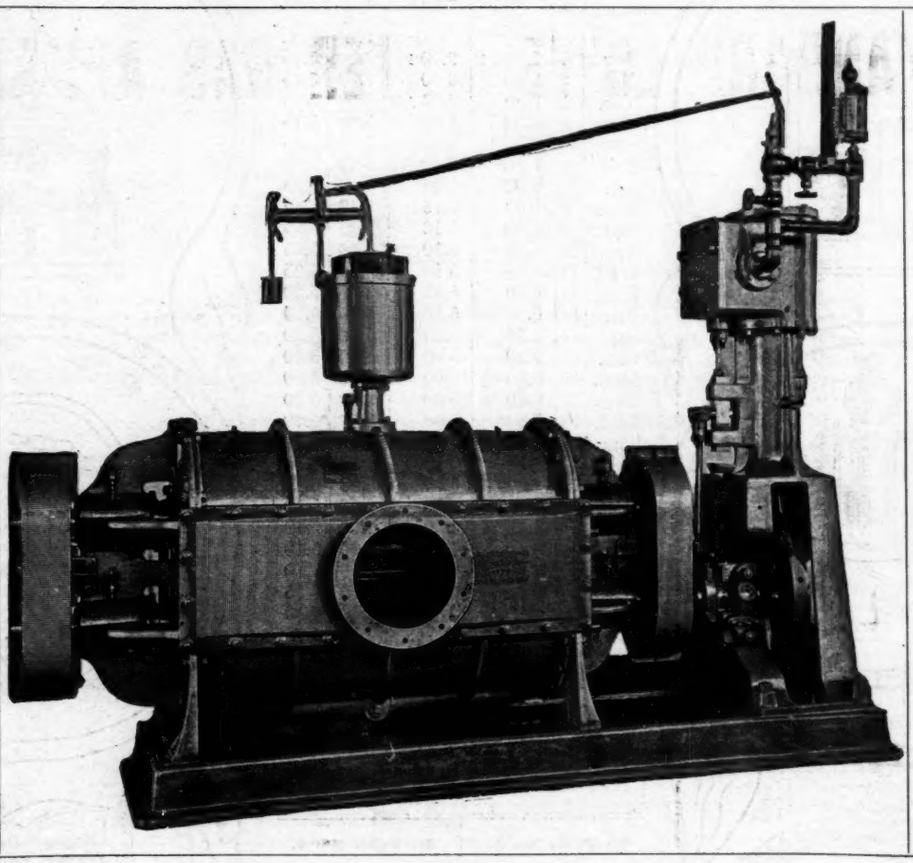

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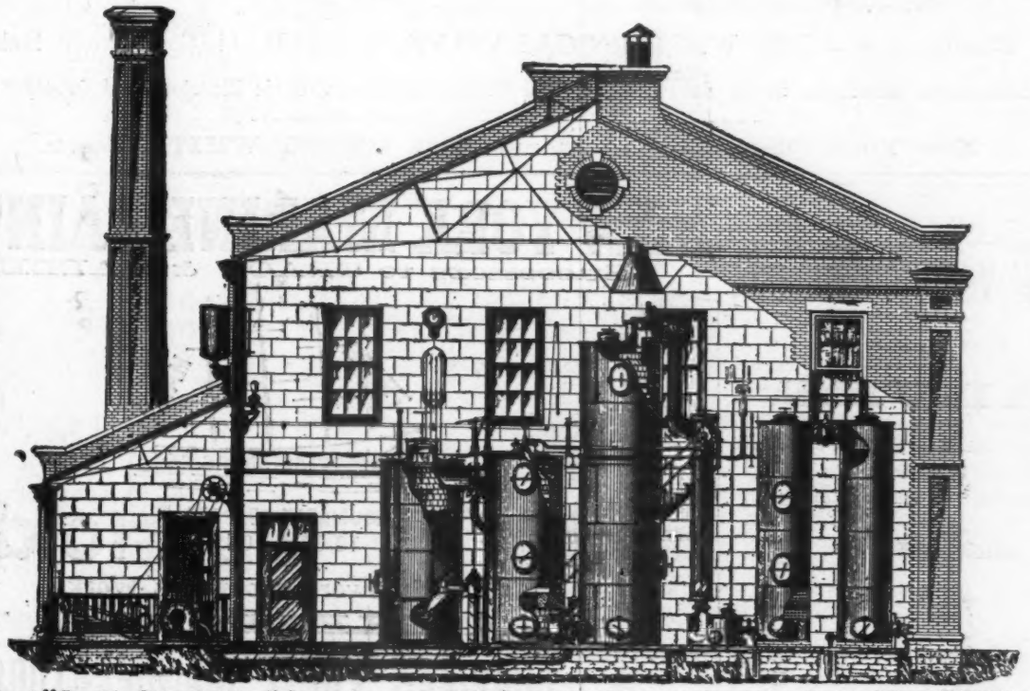

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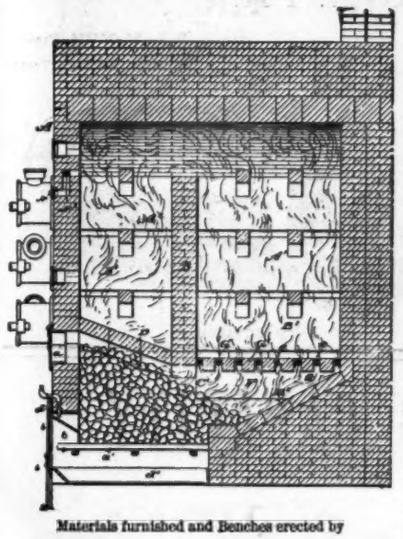

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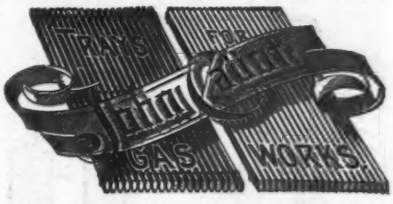

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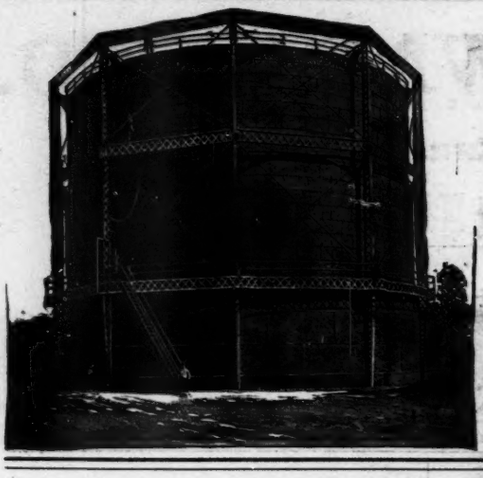

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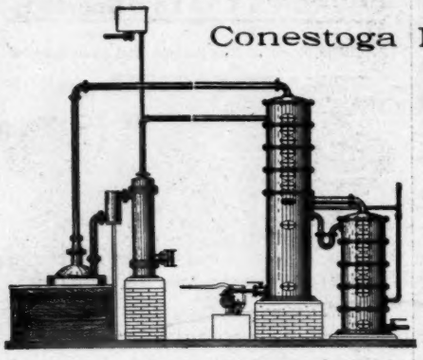

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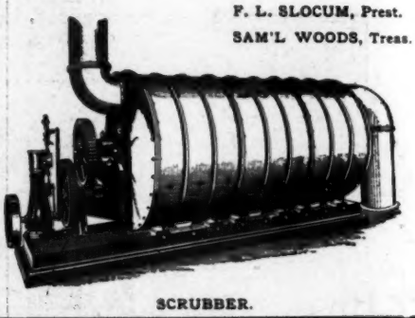

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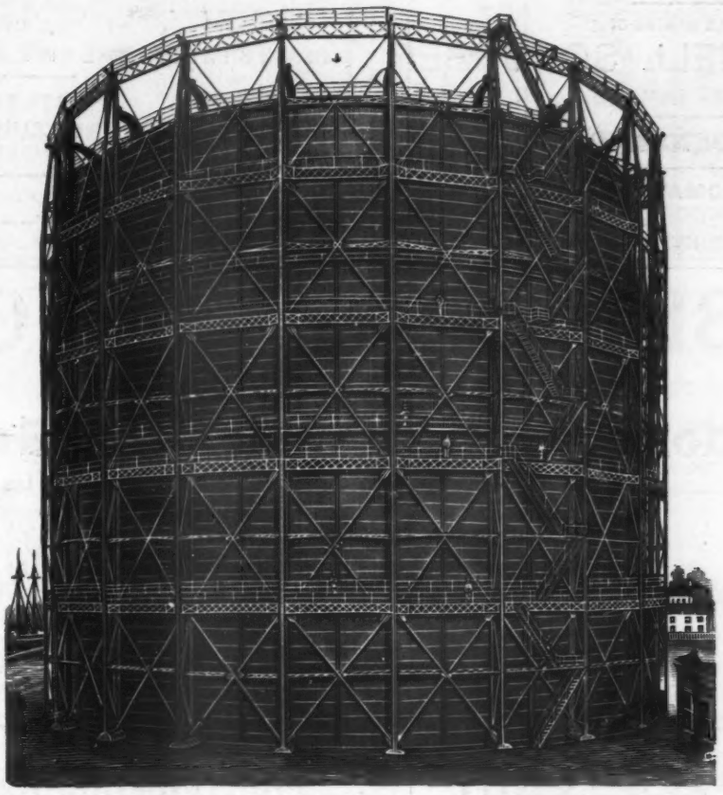

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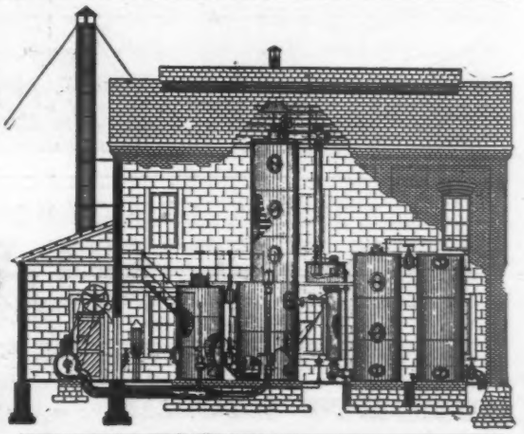

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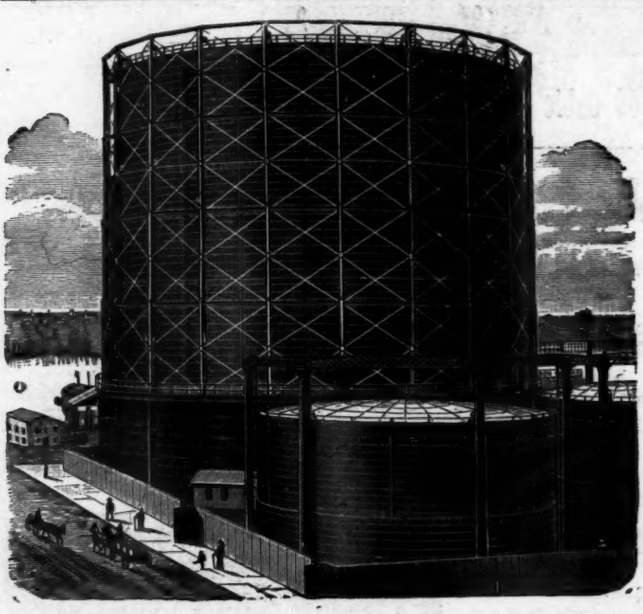

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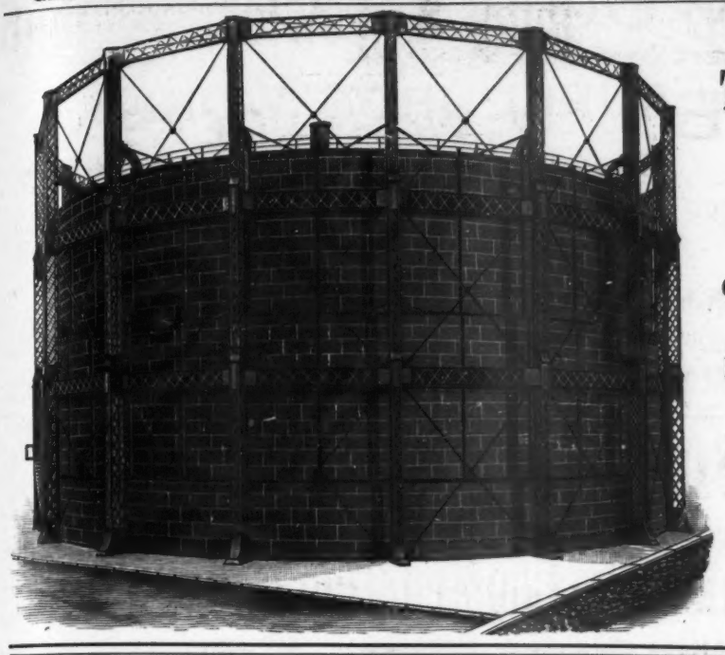

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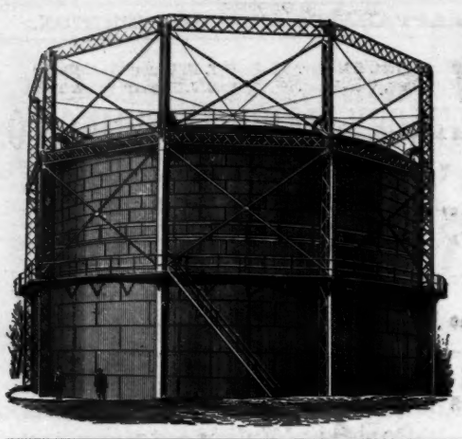

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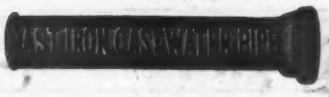

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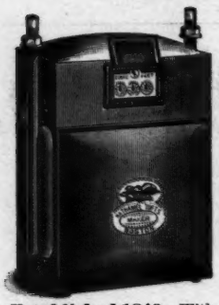

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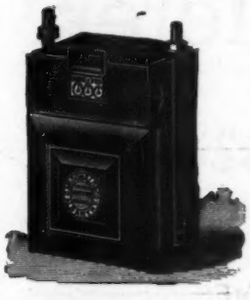

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